European Information Technology Observatory 94

European Information Technology Observatory – EITO

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Preface

This is the second edition of the "European Information Technology Observatory". Only one year after the successful launch in March 1993, the EITO is already setting the standard for market analysis and statistics on information technology (IT) in Europe. In addition, it offers an extraordinary source of information on the key technological developments and the latest applications in information and communications technology.

The EITO is a broad and unique European initiative. The EITO members consist of EUROBIT as representative of the information technology industry in Europe, the European IT trade fairs CeBIT in Hanover, SIMO in Madrid and SMAU in Milan, working closely together with the CEC. The EITO 94 has been produced with the support of the Directorate General III Industry of the Commission of the European Communities and with the support of the EITO sponsors Association SICOB in Paris and Kontor og Data in Oslo.

The EITO project for a comprehensive overview of the European market for the information technology industry coincides with fundamental steps in the integration of Europe. The idea of a European Observatory originated from the President of SMAU, Enore Deotto, and it has taken an exceptional effort by the original members to produce this unique new compendium. In early 1994 the EITO assumed the legal status of a "European Economic Interest Grouping (EEIG)". Its objective is to provide an extensive overview of the European market for information technology and to render services to this industry, users as well as public authorities.

The EITO 94 presents the most comprehensive data currently available about the IT market in Europe. It has been produced in close cooperation between the EITO Task Force experts and leading market research companies in order to discuss and improve the quality of the statistics and data. The copyright for the major parts of the market analysis, data and statistics is held jointly by EITO/GzF and International Data Corporation. The copyright for two special papers lies with EITO/GzF and Dataquest Europe respectively NOMOS ricerca.

Up-to-date and valid information plays an increasingly important role in business and political decision-making. The EITO is an indispensable source of information in marketing and technology for European market players, users of information and communications technology hardware, software and services, for trade organisations and trade fair visitors, for market analysts, for politicians, members of the European Commission and national government representatives, for organisations involved in R&D, standards and education relating to IT, and last but not least, for the media.

With its comprehensive resources of information in-depth, the EITO aims to improve the acceptance of modern information technology as well as to make its contribution to the further economic and political integration of Europe.

The initiative will be continued with annual editions of the EITO in March and an EITO Update in October as a free of charge supplement to the yearbook.

The EITO Members

Imprint

European Information Technology Observatory 1994

Publisher
European Information Technology Observatory (EITO) - European Economic Interest Grouping (EEIG)
Lyoner Strasse 18, D-60528 Frankfurt/Main

EITO Members
EUROBIT, Frankfurt/Main
CeBIT, Hanover
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European Information Technology Observatory (EITO)/Gesellschaft zur Förderung des Maschinenbaus (GzF) *for all Parts*
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International Data Corporation (IDC) *for Part One: The ICT Market in Europe, Part Two: The European Software and Services Market, The IT Market in Eastern Europe, Part Three: Statistical Outlook*
Dataquest Europe *for Part Two: Mobile Computing and Communications*
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For copies apply to
EUROBIT, Frankfurt/Main
CeBIT, Hanover
SIMO, Madrid
SMAU, Milan

Order Addresses
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Price per copy
40,- ECU (plus VAT and mailing)

Design
HWL & Partner Design GmbH, Frankfurt/Main

Production
Eggebrecht-Presse KG, Mainz

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Part One

Information Technology in Europe: The EC Commission's View

Martin Bangemann, Commissioner for Industry, Information Technologies and Telecommunications

Towards the Information Society

The new Information Society is re-shaping most of the basic aspects of our economy and society. The transition from an industrial society to the Information Society is accelerating, as a result of a process involving the progressive convergence of telecommunications, computers, consumer electronics and interactive media.

Several technologies have now reached the stage where their application will deeply affect our lives. The means to create, process, access and transfer information are remodelling the basic relationships in our societies. A new society is emerging in which services and applications provided by the Information and Communication Technology (ICT) industry change human activities as well as the economy. Productivity growth will be enhanced but at the same time new services are emerging. So the Information Society is linked to the diffusion of innovative services and products in the private business sector, in public administration, in public utilities and at individual level. This means that every economic or social actor is involved in this new challenge.

To be competitive, companies are forced into rethinking their organisation of business processes in order to exploit better the potentialities offered by ICT. The real change is not only technological; the introduction of new forms of integrated and distributed ICT is coinciding with sweeping changes in the organisational structure of the enterprises towards more flexible organisations, able to respond more quickly to the competitive environment. This is changing the role of ICT from a supportive infrastructure to a fundamental part in the delivery of major new added value. Close links between buyers and suppliers systems, as well as between groups and related firms are an important part of this new approach.

As far as the individual is concerned, from a passive role of accessing data through rather simple information systems, the users now use complex interaction with groups or company business systems. This has not only an economic and organisational impact but will also change social attitudes. The Information Society is closely linked with a new type of social behaviour: more individuality and more flexibility. At the same time, the consumer is moving towards an interactive use of multiple media: image, sound, text. This major shift in consumption has been mainly produced by multimedia products and services and their use for consumer and professional applications. Interactive TV and multimedia are becoming not only a buoyant market but also the specific domain in which data processing, telecommunications and consumer electronics will converge.

Finally, the use of ICT offers the opportunity to the public sector to recover efficiency, to provide the existing services more rapidly, to deliver new services cheaply or to outsource some services to specialists. This could be helpful in saving budgetary resources and providing basic services of better quality. More fundamentally, the access to information is breaking up the traditional boundaries between the role of the state and the market. The new ICT technologies allow a more widespread application of the "pay-per-use principle".

Structural Changes in the ICT Industry

In recent years the ICT industry has experienced a drastic structural change. Growth rates have decreased significantly, while changes in the technology and in the user purchasing patterns towards open and smaller systems have led to very low or even negative growth of sales. Value added increasingly shifts from hardware to software and, at the same time, hardware becomes more of a commodity in which it is difficult to compete profitably. Some of the largest ICT companies reported heavy financial losses and had to cut jobs. Increasing RTD (research and technical development) costs and the pressure of competition have made these investments more risky.

The basic factors of this transformation are the need to keep pace with the fast evolution of technology and the sharp reduction in unit prices under the effect of fierce competition. The introduction of innovative mass production processes and the existence of "de facto" standards has pushed companies to compete on prices. The major consequence has been the commoditisation of the products and the lesser importance given to technological performances as such. From now on and above all, it is the supply of products and services which can be clearly identified by the customers as solutions to their business needs that is required for competitive success.

Policies Followed in the US and Japan

The leverage of the new ICT technologies for the development of the overall economic system has led to adoption of major policy efforts in all the regions of the Triad. In the current mutation towards the information society, the economies which will be the first to succeed in completing the change satisfactorily will have major competitive advantages. The United States and Japan are attempting to speed up the process.

In the United States, President Clinton has launched a large programme to create the "information super-highways" that should bring the United States into the information age. This programme called the National Information Infrastructure (NII) is not limited to investment in physical infrastructures but also includes the development of new technologies and applications that will run on top of it. The programme is in three parts:

- the "information super-highways" initiative aiming at connecting universities, schools, libraries, hospitals, ministries, public agencies and business;
- the High Performance Computing and Networking (HPCN) programme for the development of new applications in major social fields such as health, education, traffic management and control;
- a programme for the modernisation of public administrations and public access to information.

In Japan, political awareness of the strategic importance of ICT for the economic development dates back to the 60s. In the early 70s, the policy of the public authorities in the ICT domain was based on instruments and actions to strenghten Japanese ICT companies. More recently, the recognized importance of "information infrastructures" for Japan's economic

development has promoted the launch of a programme under the new Japanese economic recovery plan. Within the frame of this programme several measures are planned to promote the use of ICT in major social fields, ministries and other public agencies.

The Community Technology Policy

In Europe, the same political willingness is conveyed. All the more so that the information infrastructure is increasingly regarded as a factor of competitiveness, economic growth, social cohesion and consolidating the completion of the Internal Market. The industrial policy of the Community is based on the general principle that it should promote adaptation to industrial change in an open and competitive market. It should be implemented through the creation of a favourable environment for firms' initiative. To be effective, it requires a coherent approach to all policies which impact on industrial activity.

In the area of trans-European telecommunications networks, the Commission has identified three types of networks to be developed as a priority:

- trans-European networks between administrations to ensure the management of the integrated European market and the freedom of movement of goods, services, capital and soon, people, as well as to improve the decision-making process within the Community;
- a European Integrated Services Digital Network (EURO-ISDN) devised as the successor of the telephone network out of which it evolves in order to service the communications needs of economic operators participating in the Single Market;
- broadband telecommunication networks to meet emerging requirements and pave the way to future telecommunication services networks.

European networks are the technological basis for the new Information Society. However, this is only a necessary condition. In order to create new jobs and services we have also to stimulate demand by European applications and to strengthen technological mastery and dissemination.

What Challenges in Europe for ICT?

The move towards the information society is irreversible, affecting all aspects of society and presenting several opportunities. The European industry has to overcome several challenges if it wants to seize these opportunities fully, and to compete successfully on the world market. How the European ICT industry will face these challenges will determine the benefits that can be gained.

Five basic issues are to be considered:

Diffusion of best practice and development of trans-European ICT applications

As ICT penetration increases, the conditions under which ICT are used becomes an important issue. A new approach to ICT is required, giving priority to the effective use of the technology rather than a technology-push policy as has often been the case in the past. Deeper attention has be paid to the conditions under which ICT are used. From the major consequence of ICT misuse has arisen the need of a "business process re-engineering". The introduction of ICT should go hand-in-hand with the identification of the companies' strategic objectives, of their appropriate organisation and support to be provided by the information system.

To avoid proliferation of incompatible applications and services, the launch of new European applications project could foster market catalysation, and at the same time promote the development of common approaches and standards.

Major public services, public administrations and teleworking could benefit from the development of such application projects.

The exchange of data between administrations, as developed in the IDA (Interchange of Data between Administration) programme, will be of major importance for reducing custom controls and for the functioning of the Single Market. Results achieved within the RTD programmes in the areas of communications technologies (ENS, AIM, DELTA or DRIVE) could also contribute to the launch of new initiatives.

Creation of a regulatory environment

The establishment of a regulatory environment is a basic issue for the creation of a common information space. Since the practical creation of the information infrastructure will depend primarily on private sector investments, it is essential for governmental authorities to enable private actors to undertake such investments and guarantee that they are used in the community's interest.

The objective is the promotion of efficient functioning of open and competitive markets in communication services and equipment and to guarantee universality of services and speeding up of the standardisation process.

The full opening up of the telecommunications services to competition decided by the Council in its Resolution of 22 July 1993 meets these requirements. The traditional market structure based on the existence of national monopolies no longer reflects the current requirements. A new policy is necessary to stimulate the development of new services and the provision of the trans-European basic telecommunication services. The benefits generated by this policy will be for operators, companies including SMEs (Small and Medium Enterprises) and the general public.

As far as standards are concerned, they are becoming of greater importance with the advent of interworking between computers, which places far greater demand on the standardisation process than earlier when the concern was as simple as exchanging data between them. Despite the major efforts by the industry and standardisation bodies, major challenges remain for effective distributed systems of tomorrow, including the relationship with official standards, those developed by industry consortia and the so-called "de facto" standards.

Harmonisation of national legislations on copyright and data protection are also important issues. It is necessary to solve them to help to create a business environment for using ICT in Europe.

Ensurement of the provision of the basic trans-European communication services

A third issue is the enhancement of the functioning of the single market, notably through the establishment of the basic trans-European communication services. Fundamental obstacles still impede the full functioning of trans-European communications such as incompatibilities of standards and non-interoperabilities of networks.

Precisely, the problems are not only technological but are more the result of the organisation of the market: high level of tariffs, very high prices for high speed lines, the absence of telecommunication operators of European stature and the non-existence of basic services at European level except vocal telephony or services based on it.

The development of European-wide ISDN and broadband networks furnishing the basic telecommunication services are important steps to be undertaken to guarantee unified, open and interoperable telecommunications services over the whole Community territory.

Development of training related to ICT

The changes accompanying the spread of ICT will require major training support, both on the side of the users and the suppliers. The cultural and social changes will require corresponding adaptations of the education systems and the development of special teaching infrastructures. In particular, the opportunities offered by remote training should be better exploited. The Member States have a lengthy experience in the domain of education and training in ICT, but not enough efforts have been devoted to the application of new technologies to training and education.

A major training effort should be addressed to the diffusion of the basic capabilities and knowledge that allow the exploitation of the opportunities offered by new ICT products and services.

As far as suppliers are concerned, it should be important to ensure the training of engineers of which the European ICT industry has a shortage: system engineers, network engineers, software engineers, specialists in security, opto-electronics, vision systems and computer-integrated manufacturing.

Improvement of the performance of the European ICT industry

A major challenge for Europe is to ensure the development of innovative applications, adapted to the requirements of the users. This involves the ability of pioneering new products and services and of disseminating among the users the innovative culture required to raise the level of demand. Mastery of technology and access to advanced technology are essential elements to be competitive and to strenghten the position of the European ICT industry. At the same time, additional economic growth and employment, which would result from implementing the information infrastructure, depends on a strong European ICT industry.

A major RTD effort is required. The rapidity of technological progress makes RTD orientation and support a basic factor of competitiveness. The 4th Framework Programme sets up the technological priorities and establishes the financial resources for supporting Community RTD activities in the period from 1994 to 1998. Information and communication technologies will continue to have a central role: a significant part of the funds of the Framework Programme will be devoted to these technologies.

New strategical orientations characterise the programme: the "horizontal" character of ICT, in particular, is emphasised with regard to the ability of these technologies to support and stimulate technological innovation in a wide range of applications. Co-operation between suppliers and user companies, to move technological innovation through the value added chain, will be particularly encouraged. The industrial orientation of RTD has been emphasised, by identifying aggregations of research themes, or "clusters" of projects, in which interdisciplinary work can be organised towards very specific technological objectives.

In order to accelerate the process of dissemination of innovations, the programme includes actions to favour "best practice" in the use of new technologies. Important new elements of the 4th Framework Programme are also the coordination of RTD actions with other national and international programmes, notably EUREKA, as well as actions regarding the diffusion of RTD results.

RTD support represents a very important element to develop conditions of competitiveness for the European ICT industry, but cannot be sufficient if it is not embedded in a coherent industrial policy. Specific actions of industrial

policy are to be defined to accompany RTD activities. For example, the promotion of technology and industrial watch can provide further analysis of new technological and industrial evolutions. For both companies and public authorities, it will provide the global framework of understanding for the definition of strategic orientations and for the decision-making process.

Similarly, the valorisation of the results of RTD can contribute to filling the gap between technical results and industrial needs, whereas market forces do not push sufficiently their diffusion and take-up. For example, in the multimedia domain, the establishment of pilot sites with multidisciplinary teams would encourage the development of specific multimedia applications and create awareness among potential users of the opportunities offered by these technologies.

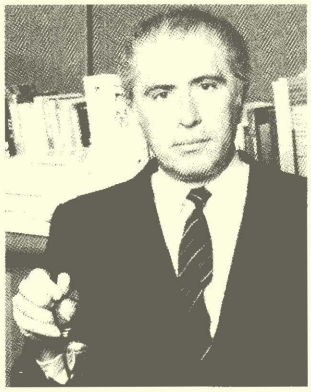
Finally, in a globalised context, it is necessary to adapt the industrial and commercial policy to the new international situation. With globalisation, the existence of unfair competitive practices in the various markets of the Triad creates competitive advantages which could be decisive and seriously handicap European companies. For that reason, levelling the playing field should become a higher priority and should require multilateral or bilateral negotiations. Furthermore, the launching of programmes for international co-operation would help the European companies to develop international alliances and become global.

Information Technology in Europe: The Industry's View

Bruno Lamborghini, President of EUROBIT

1993 was a key year for the European information technology industry, for two main reasons.

The first, negative reason was the worsening situation of industry and the market crisis. Market trends and corporate results confirm that 1993 was the worst year in the history of information technology in Europe. However, the crisis now seems to have bottomed out.



The second, positive reason is provided by growing signs that a new IT industry and market growth cycle is slowly beginning, from an important new basis.

The convergence between information technology and telecommunications is a new trend which will influence the development paths of both fields. The creation of new markets and new applications which can fuel new companies and new jobs is an increasingly tangible prospect.

The start of this new cycle has coincided with the birth of the European Union following the ratification of the Treaty of Maastricht: this is a significant coincidence and should set off the mechanisms for a recovery both of Europe and of European industrial competitiveness.

The aim of this second report of the European Observatory on Information Technology is to highlight the contribution which the integration and convergence of IT and telecommunications into what can be called an Information and Communication Technologies industry (ICT) can make to the growth of the new united Europe.

This new technological cycle is a major challenge for Europe. As the White Paper approved by the European Council last December clearly indicates, intelligent, innovative use of information technology can help Europe take a major step towards achieving two fundamental objectives: faster integration and expansion of the Community, and construction of a solid basis for a new cycle of economic growth and rising employment.

The transformation underway in Europe's IT industry is a painful and costly process, and still incomplete. But I believe it is a transition towards a new age in the industry, geared to the new requirements of society and the economy.

Compared with other industrial areas, the difficulties and costs of change have been particularly high in Europe, because of the severe economic slowdown in 1993, which caused a sharp fall in demand for capital goods. Furthermore, market competition was particularly intense in 1993, with the price war spreading from personal computers and hardware to become a significant trend in the software and services field.

Nevertheless, a number of signs indicate that investments are slowly beginning to pick up, together with demand for IT products and systems

(which today is increasingly tied to general trends in capital goods, although it tends to anticipate the capital goods cycle).

These signs will gradually strengthen as confidence grows in a solid economic recovery in Europe. But the strongest stimulus for a recovery in IT demand can only come from a renewal of the industry's product and service offer. Rapid technological advances have made immense computing power available at minimum costs, creating the conditions for development of advanced applications to meet the growing needs of the new Europe's corporate sector and private citizens.

Today companies are streamlining their corporate processes in order to improve efficiency and competitiveness; they need to implement sweeping process re-engineering programmes; they need to optimise internal and external communications and interactive information flows. The new information technology based on computer networks, distributed architectures and client-server structures can meet these needs.

Information and Communication Technology can also offer solutions to European citizens' demand for new jobs, greater security, a better quality of life; it can be used to create new activities, develop information networks, improve administration and public services, guarantee security and monitoring systems, simplify many aspects of people's daily lives.

As ICT spreads, it will bring major changes in the workplace, enabling people to reduce the constraints of time and space so that their jobs can be structured to their individual needs, thus greatly increasing productivity and quality. The use of computer networks removes the constraints on the physical location of the worker. Teleworking is spreading rapidly in the United States and in a number of European countries. It is not without problems, but it provides a degree of flexibility that would have been unthinkable in the past, to the benefit of both the employer and the employee.

ICT will transform training, enabling learning to be tailored to individual vocations and skills, again through adjustments to the time and space variables. Long-life learning will be possible through home-training processes based on tools that can be personalised according to individual needs. Similar changes will be possible in basic services such as healthcare.

It is no coincidence that teleworking, teletraining and telemedicine are priorities in the White Paper presented to the European Union Council by President Delors last December; they are social application areas of crucial importance in improving the quality of life. These developments are not part of a remote and improbable future; in part at least, they are already possible today.

Technology and its applications evolve extremely rapidly; the mass diffusion of personal computers, for example, began only ten years ago. Since then, the personal computer has revolutionised production and the workplace. The development of ICT applications could lead to a second and no less important revolution. Rising demand for ICT products and services will be a powerful factor fuelling a recovery in investments in general.

The developments brought by the convergence between IT and telecommunications mean that companies restructuring and strategic planning will need the support of a coordinated European-wide technological policy.

The US Administration has launched an industrial and technology policy designed to strengthen industrial competitiveness by creating synergies between public action and the private sector. This policy has two aims, to redirect military research towards civil applications and to promote the development of major information infrastructures, the so-called information highways.

The Federal Administration's role is no longer to provide public money to finance major research programmes or major public infrastructures. Rather, it is to act as a catalyst for private investment in infrastructures through deregulation policies, standardisation, support for pilot projects and promotion of social applications.

The launch of the National Information Infrastructure (NII) project, combined with an intelligent deregulation policy for communications, is encouraging dozens of new private initiatives for the development of technologies, networks and applications. It has fuelled a wave of agreements and acquisitions and is revitalising the ICT industry by speeding up the convergence between the three "Cs" (Computers, Communication and Content), where the third "C" stands for media, information providers and a growing number of operators in entertainment and the arts.

Thanks to this project, with the Federal Government playing an intelligent, but not predominant role as the promoter of private initiative, US industry will enter the world markets of the new information age with fresh competitive vigour.

Europe must take up the challenge.

It has no shortage of skills, know-how, industrial structures and technological and entrepreneurial capabilities. But certain conservative attitudes need to change, together with a general unwillingness to implement sweeping change and the tendency to defend at all costs the privileges created by monopolies and closed markets.

The European IT industry is not afraid to meet a very difficult challenge in the new global scenario. It is in the area of new technologies, in particular ICT, that Europe will face fierce competition from two large regional areas: North America, where the NAFTA agreement for a common market in the USA, Canada and Mexico has paved the way for solid economic integration, and the Pacific Rim, where annual growth rates are generally above 8%.

The European IT industry has implemented and is implementing massive changes in order to meet this challenge. It has paid and is paying a considerable price to defend efficiency, control costs, maintain high quality levels and innovation skills.

But today the industry perceives clearly that, through the changes taking place in information technology and the creation of the European Union, new opportunities are opening up for companies that can respond fast. Europe possesses valuable resources in many of the technological, product and service areas typical of the new ICT sector and is capable of competing on an equal footing with the other world areas.

To win the challenge, however, the European IT industry needs to operate in the same type of environment as the IT industries in other areas. In particular, the conditions must be created to enable the potential new demand for ICT services and applications to take off. This involves consistent deregulation policies in communications (the European Commission has played a most important role in this area), reviews of education/training systems, specific objectives for research programmes.

European education can be harmonised and aligned more closely with the skills needed in the new competitive scenario through widespread use of computers and IT networks in schools and the permanent education system. The computer should come to be a basic tool at every scholastic level, on a par with pens and textbooks.

Japan is well aware of the importance of computers in education and has launched a major programme to promote IT in all schools by making computer literacy a compulsory requirement at every scholastic level.

Europe's IT research programmes, in particular the Fourth Framework Programme, must contribute to the development of innovative IT applications through coordinated rather than fragmented projects, in order to foster the creation of new activities and new enterprises.

However, the core of the IT and communications policy must be a major project for a European Information Infrastructure.

Europe today is a patchwork of incompatible telecom data networks, with extremely high communication costs and low-quality services. This situation is an obstacle not only to a new phase of IT demand. It is also one of the major obstacles preventing the European corporate sector from maintaining adequate levels of competitiveness; it is an obstacle to improvements in the living standards of European citizens; it is an obstacle to administrative and institutional progress; it is an obstacle to the diffusion of the knowledge needed to improve the quality of the most important strategic resource in the 1990s: human capital. Only effective synergy between IT and telecommunications can ensure the development of efficient infrastructures and enable the entire European system to make a quantum leap forward.

A European Information Infrastructure project is therefore an urgent priority. "Building the European Information Highway" – as the title of a current EUROBIT initiative points out – is the conditio sine qua non for Europe to remain competitive in a global world economy. "In an information society on the threshold of the 21st century, information must be available in the right form, at the right time, in the right place and at an affordable price. To achieve this we need a European Information Infrastructure" (EUROBIT Memorandum).

In this area, the European IT industry expects the European Commission and the member-state governments to play their part: to create the necessary framework conditions, to act as catalysts and to harmonise regulations and standards.

The necessary framework conditions depend on open, fair competition through deregulation of telecommunications services, fair assignment of limited resources like frequencies, promotion of cost-based tariff policies and consistent fiscal policies.

To act as a catalyst, the European Commission should link community research programmes more closely with applications. In particular, it should promote pilot projects for applications in public services, in public administration, in trans-European network applications, where innovative technologies can be tested and information networks set up. Harmonising standards is vital to ensure interoperability, true openness, protection of privacy, information security and confidentiality.

A European Information Infrastructure based on ISDN and broadband technologies, as recommended in the European Union White Paper, is the foundation for the creation of a Common Information Area. After the Single

Market, the Common Information Area must be the next major frontier for the construction of Europe.

This is the goal pursued by the IT industry represented by EUROBIT, which pledges its full support for the implementation of the European Commission's proposals.

EUROBIT is the only organisation that represents the whole of the IT industry operating in Europe. The companies and trade organisations belonging to EUROBIT include many of the world's largest and most efficient IT vendors. Their experience covers hardware, software and services, and ranges from technology to applications for specific industries (in both the manufacturing and services sectors), for commerce and for public administration.

EUROBIT is ready to cooperate with the European institutions on the development of a Common Information Area in Europe, for which it has concrete proposals and ideas. EUROBIT believes it has a responsibility to contribute to the definition and success of a project of fundamental importance not only for the development of the ICT industry, but also for the competitiveness and future growth of Europe.

The Information and Communications Technology (ICT) Market in Europe

1. Introduction

Great opportunities are emerging for the European Information and Communications Technology (ICT) market.

An ICT revolution is taking off just as consolidation pressures have reached their heaviest for a long time. Today the IT world faces a mixed short-term outlook. Suppliers are suffering sharp falls in demand due to bad economic conditions. This in turn has exposed the industry's underlying structural problems, bringing new rounds of urgent restructuring.

Nevertheless, tight user cost controls have not killed demand for new products and services in most countries. Business process reengineering (BPR) is a key driver. BPR is boosting growth of more business-oriented IT consulting services, implementation services and application software.

However, the ups and downs of today's markets are overshadowed by radical longterm changes racing over the horizon.

Telecommunications, computers and information content are converging into a single medium at stunning speed. This development is remarkable in many ways:

- The business opportunity is vast.
- It involves both rival industries and sectors previously unconnected.
- It is suddenly turning interactive multimedia into a commercial reality.

Already users are starting to change the type of ICT technologies and services they buy. Meanwhile the latest technology developments (such as personal digital assistants, wireless communications, local area networks, interactive CDs) are triggering new links between IT, entertainment and communications companies.

These new trends are definitely changing the pH factor in the ICT market pool.

On the demand side, new ICT applications will bring better benefits for the traditional business user. Even more important will be a new breed of ICT customer: residential personal users. They will demand innovative technologies and services to satisfy traditional and new needs for both business and entertainment. This new user segment will create extra demand, bringing a significant boost to overall market growth.

The supply side has caught gold fever. Everyone – from telecoms and information technology companies to cable, media, and entertainment outfits – is rushing to combine interests and business efforts.

Leading global corporates in these sectors believe they must be in the forefront of the convergence movement to capitalise on the decade's premier growth opportunity. One result: the wave of telecommunications and media mergers and acquisitions over recent months.

Noted commentators say that the implications for virtually every segment of our society are dramatic. They forecast that new products and services generated by convergence of the IT, telecommunications, consumer electronics and media industries will change lifestyles and working methods.

In Europe today the adoption of ICT technologies plays a crucial role in developing economic competitiveness. The Trans-European Networks project, which includes a major ICT component aimed at creating Europe-wide information highways, has moved centre stage in EU plans to stimulate growth. Looking to the next century, EU leaders recognise that powerful ICT networks will be essential to drive competitiveness, innovation and job creation.

1.1. IT (Information Technology) and ICT (Information and Communications Technology) Market Size

This section looks in detail at the current state of Europe's IT and ICT markets, noting important trends over the last year.

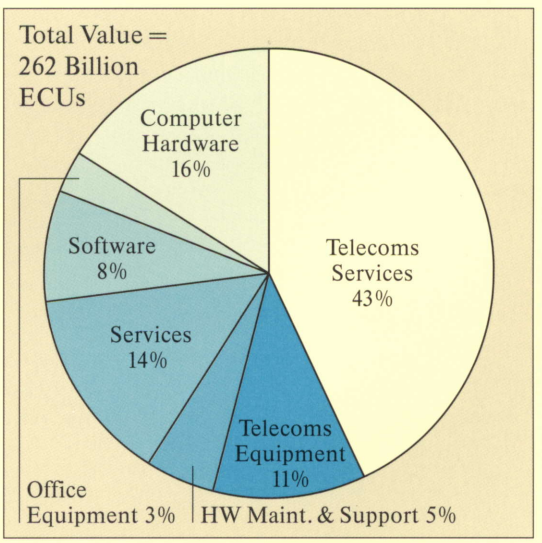
The European ICT market was worth 262 billion ECUs in 1993. Of this, 121 billion ECUs came from core information technology categories – office equipment, electronic data processing equipment, software, professional services, processing services, network services, hardware maintenance and support. The remaining 141 billion ECUs represented telecommunication equipment and services.

With recession freezing growth since 1991, the weight of Europe's ICT market within the world ICT total has fallen slightly. In 1993 Western Europe accounted for 33.8% of total world market: 34.5% of total IT and 32.9% of communications.

	1993	% of IT	% of ICT
Computer Hardware	43	35	16
Office Equipment	9	7	3
Software	20	17	8
Services	36	30	14
HW Maintenance and Support	13	11	5
Total IT	**121**	**100**	**46**
Telecommunication Equipment	29		11
Telecommunication Services	112		43
Total ICT	**262**		**100**

Note: (*) Europe includes the 12 EU and 5 EFTA countries (Switzerland, Austria, Sweden, Norway, Finland)
(**) It should be noted that all figures have been rounded to the nearest billion ECUs at 1992 constant exchange rates. Total and percentages may not add up due to rounding.

Table 1
European (*) Information and Communications Technology (ICT) Market, 1993. Billion ECUs (**)



Source: EITO

Figure 1
Western European (EU & EFTA) Information & Communications Technology (ICT) Market by Product, 1993

Table 2
Worldwide IT Market by Region: Percentage Breakdown Calculated on Market Values. Billion ECUs. 1992-94

	1993 Value	1992 %	1993 %	1994 %
Western Europe	121	35.1	34.5	33.7
EU	104	30.2	29.6	28.8
EFTA	17	4.9	4.9	4.8
Eastern Europe	3	0.7	0.8	1.0
US	137	37.9	39.1	39.4
Japan	56	17.3	16.0	15.7
4 Tigers	5	1.4	1.5	1.5
ROW	28	7.6	8.0	8.6
Total	**350**	**100.0**	**100.0**	**100.0**

Note: 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
ROW = Rest of World

Table 3
Worldwide ICT Market by Region: Percentage Breakdown Calculated on Market Values. Billion ECUs. 1992-94

	1993 Value	1992 %	1993 %	1994 %
Western Europe	262	34.2	33.8	33.3
EU	226	29.5	29.1	28.7
EFTA	36	4.7	4.7	4.6
Eastern Europe	13	1.7	1.7	1.8
US	287	36.6	37.0	37.0
Japan	126	17.0	16.2	15.9
4 Tigers	25	3.2	3.3	3.3
ROW	62	7.4	8.0	8.6
Total	**775**	**100.0**	**100.0**	**100.0**

Note: 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
ROW = Rest of World

Five consecutive years of falling market growth culminated in unfavourable currency variations in 1993. This reduced European ICT market size compared in homogeneous currencies to the other worldwide regions. By contrast the ICT markets of the US and Four Tigers (South Korea, Taiwan, Hong Kong, Singapore) continued to gain share of the worldwide market.

The US IT market recovery, while moderate by historical standards, shines in contrast to other developed economies. In 1993 the US IT market grew by 7%, a similar pace to 1992 (7.7%). Its ICT market overall grew by 6.7% in 1993.

The combined Four Tigers ICT markets continued to be among the fastest growing businesses in the world. Korea and Taiwan dominated the scene. Their combined ICT market growth was 11.6% in 1993. Due to the relatively low rate of penetration of ICT technologies, potential for market growth in this area remains strong long-term.

Japanese share of the world ICT market decreased. Following 1992's sharp fall in the domestic IT business, came 1993's still negative growth rate (-3.8%), due to persistent economic recession and price erosion.

1.2. IT and ICT Market and Current Economic Situation in Europe

Europe has seen increasing correlation between trends in GDP, investment in machinery and ICT expenditure. Short-term extrapolation of these trends confirms the picture of slow European recovery in 1994.

As ICT penetration increases, both economic and ICT market indicators increasingly follow the same patterns of nominal growth. (The economy tends to register slightly higher growth rates, due to lower price pressures.)

Economic upturns do not by themselves create a healthy ICT market. They are, however, a key ingredient. A better understanding of when economic activity will pick-up helps predict upturn in the ICT market.

Before discussing short-term ICT market trends, it is worth outlining the major assumptions behind forecasts about the European economy. As we publish, the following features characterise the economic outlook:

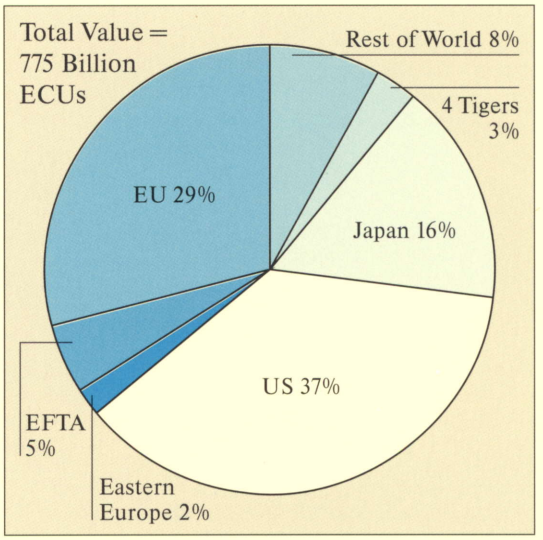
i. *Economy:* After 1993's decline in Community GDP (the first fall since 1975), forecasts for growth in 1994 are modest. The turning point is due in mid-1994. However, the latest forecast is uncertain, depending on four factors:

- further interest rate falls;
- a gradual pick-up in world trade;
- a gradual improvement in Europe's competitive position;
- a rebound in consumer and business confidence.

EU forecasters stress that only moderate recovery is likely. Significant factors threaten growth of all GDP components - private and public demand, imports, investment. These include absence of favourable exchange rate movements, decline in consumers' real disposable income and low capacity utilisation, ruling out a substantial upswing of investment in equipment.

ii. *Investment:* The demand component most affected by the current downturn is investment in equipment. It has suffered a third consecutive decline in real growth since 1990. This is a cyclical response to gloomy domestic and foreign demand prospects, the low degree of capacity utilisation, and high longterm real interest rates in many European countries.

Nevertheless, an improved business climate should trigger a moderate revival of equipment investments real growth in 1994. Likely drivers



Source: EITO

Figure 2
Worldwide ICT Market by Region, 1993

are continuing falls in interest rates, gradually improving demand prospects (particularly in non-European countries) and further strengthening of profitability.

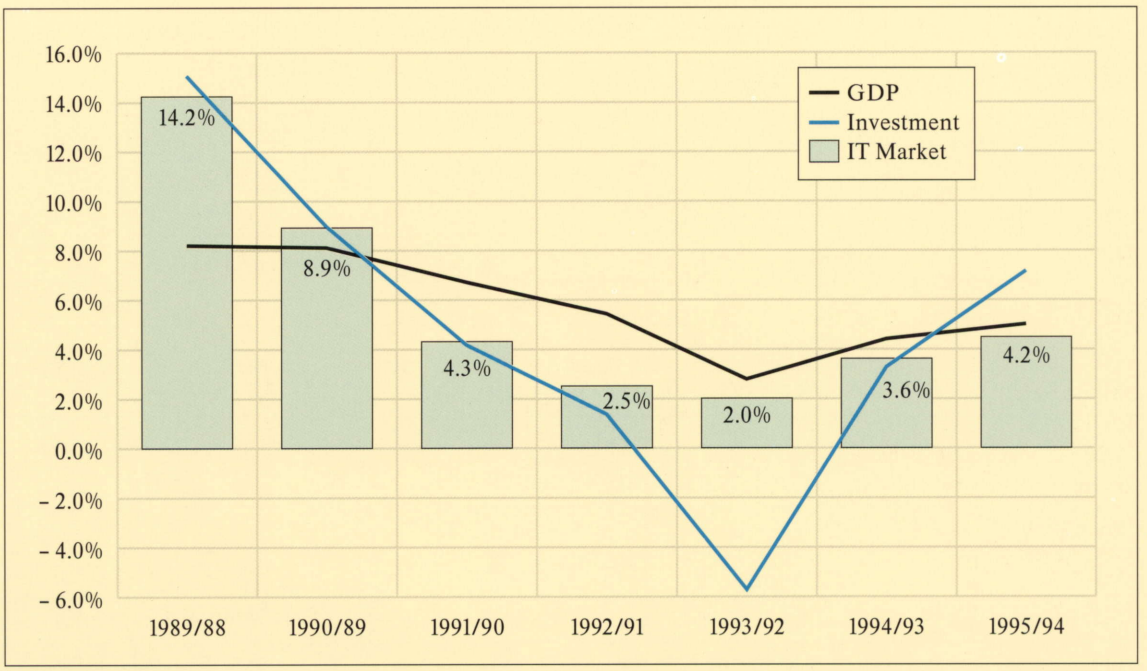
iii. *Country differences:* Variations among Europe's national economies are intensifying. Predictions are that real GDP growth will turn positive across Europe in 1994. Nevertheless, it will remain very subdued in Germany, Belgium, France and the Netherlands. In EFTA and other EU countries, real GDP growth of 1% to 2% is forecast. Only Denmark, Ireland and the UK are expecting expansion close to potential, at around 2.5%.

iv. *Risks and uncertainties:* Three major uncertainties characterise current economic forecasts:

- The depth and length of recession in Germany.

The pace and duration of the downturn could be worse than expected, depending on two factors. First, the easing of monetary conditions

Figure 3
Western European GDP, Investment and IT Market Actual Growth and Forecast, 1989-1995



Source: OECD, EITO

leading to substantial cuts in interests rates. Current inflationary pressures may prevent this happening. Second, the gradual strengthening of world trade may not happen as quickly as forecast. That would mean problems for German exports.

- The degree to which recession in Germany will affect its neighbours, on top of weak demand at home.

The latest forecasts suggest their real GDP growth will outpace Germany's both in 1993 and 1994. Given the high degree of interdependence between these countries, the downturn in economic activity maybe self-reinforcing.

- Inflation and growth outlook in countries which devalued their currencies in the autumn 1992 foreign exchange turbulence.

Recent gains in competitiveness might erode more quickly than anticipated. The threat comes if current levels of stagnation do not stop the reemergence of imported inflationary pressures.

As a result, worldwide and local recession has weakened IT and communications markets in most European countries: Because of Europe's slower than expected recovery from recession, the IT market grew by 2.0% in 1993. Recovery is now forecast to arrive in 1994, when growth will increase to 3.6%. The communications market grew by 6.2% in 1993 and is anticipated to grow by 6.3% in 1994. Double digit growth is continuing only in countries where the IT market made a late start.

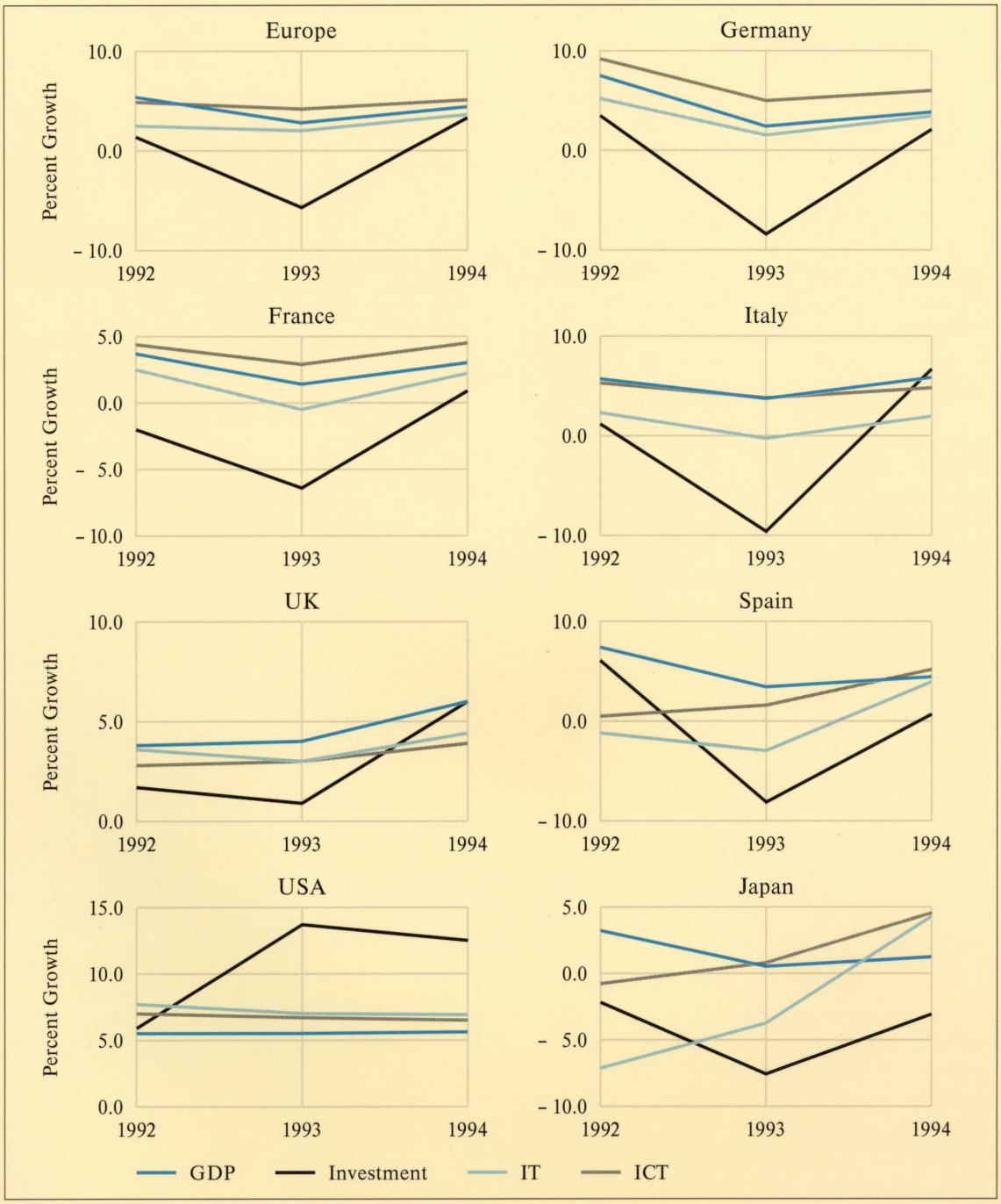
Region	1992	1993	1994	Region	1992	1993	1994
Europe				**UK**			
GDP	5.4	2.8	4.4	GDP	3.8	4.0	6.0
Investment	1.4	- 5.7	3.3	Investment	1.6	0.9	6.0
IT	2.5	2.0	3.6	IT	3.6	3.0	4.4
ICT	4.9	4.2	5.1	ICT	2.8	3.0	3.9
Germany				**Spain**			
GDP	7.5	2.4	3.8	GDP	7.4	3.4	4.4
Investment	3.5	- 8.4	2.1	Investment	4.4	- 7.1	0.5
IT	5.2	1.5	3.4	IT	- 1.2	- 3.0	3.9
ICT	9.2	5.0	6.0	ICT	0.5	1.6	5.2
France				**USA**			
GDP	3.7	1.4	3.0	GDP	5.5	5.5	5.6
Investment	- 2.0	- 6.4	0.9	Investment	5.9	13.7	12.5
IT	2.5	- 0.5	2.2	IT	7.7	7.0	6.9
ICT	4.4	2.9	4.5	ICT	7.0	6.7	6.5
Italy				**Japan**			
GDP	5.7	3.7	5.8	GDP	3.2	0.5	1.2
Investment	1.2	- 9.6	6.7	Investment	- 2.2	- 7.6	- 3.1
IT	2.3	- 0.3	1.9	IT	- 7.1	- 3.8	4.2
ICT	5.3	3.8	4.8	ICT	- 0.8	0.8	4.5

Table 4
GDP, Investment (*), IT and ICT Trends (Nominal Growth), 1992-94

(*) Gross private non-residential fixed capital formation

Source: OECD, EITO

Figure 4
GDP, Investment (*), IT and ICT Trends (Nominal Growth), 1992-1994



(*) Gross private non-residential fixed capital formation

Source: OECD, EITO

1.2.1. IT Trends

Trends by country

Adding new short-term economic assumptions to the latest IT market forecasts produces significant changes in the pattern of growth, due to the characteristics of each national market.

In 1992, UK and Germany drove European IT growth. Italy, France and Spain held the market back. In 1993 good news came only from the UK, among the top five countries. Tough times continued in France, Italy and Spain, while the German economy caused great concern.

Germany: sick for how long?

Germany accounts for 24% of the Western Europe IT market. As a result, short-term European growth will depend on how rapidly German users recover their confidence. If they continue to make IT investments a high priority despite economic downturn, they will certainly help drive recovery.

Last year increasing concern in Germany's economic community led to a loss of confidence. Cuts in technology investments followed. Overall, the 1993 growth rate was 1.5%. However, some factors still justify optimism about a German recovery in 1994, when growth is forecast at 3.4%.

France: a deflated market

France's 1993 growth totalled no more than -0.5%, as the market continued to be among the weakest in Europe.

France will make a small contribution to European IT growth over the next two years. The market is forecast to grow by 2.2% in 1994. This weakness comes from a combination of decreasing business confidence with falls in external spending.

	1993 Value	1993 %	1993/92 %	1994/93 %
EU	104	86	1.5	3.5
Germany	29	24	1.5	3.4
France	21	17	- 0.5	2.2
UK	20	17	3.0	4.4
Italy	13	11	- 0.3	1.9
Spain	5	5	- 3.0	3.9
Other EU	15	12	5.7	5.4
EFTA	17	14	4.8	4.3
Western Europe	121	100	2.0	3.6

Table 5
European IT Market by Country: Percentage Breakdown Calculated on Market Values. Billion ECUs

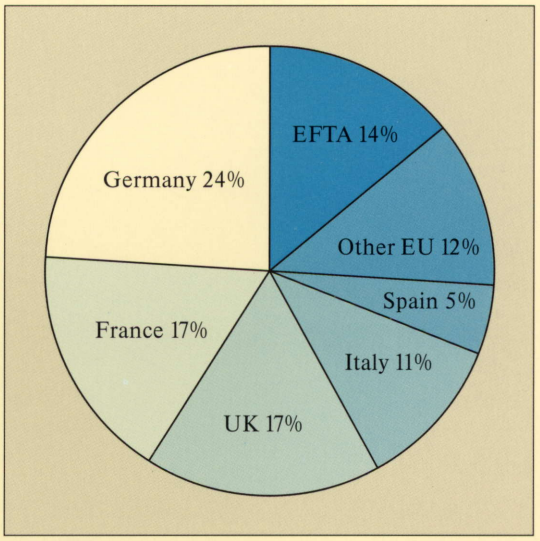
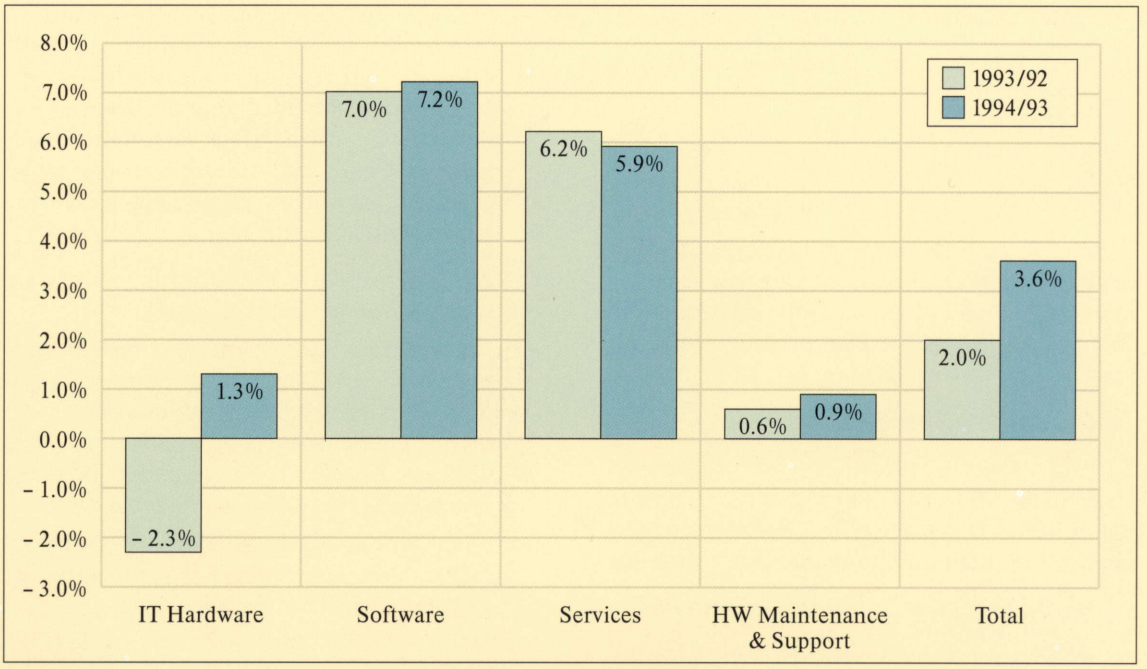


Figure 5
Western European IT Market by Country. Billion ECUs

Source: EITO

Figure 6
Western European IT Market Value Growth by Product Segments



French IT budgets generally set external spending above the European average. That spending is more focused on longterm contracts for programming, systems integration, and other services. Price pressure and postponed contract renewals therefore hurt growth of market value.

United Kingdom: upward trend continues

With 3.0% growth in 1993 and 4.4% predicted for 1994, the UK market continues its good performance. One driver is an improving economic environment. Exports and manufacturing output are rising. Business investment is increasing. Another key factor is the adventurous attitude of UK users. Compared to other Europeans, they are showing greater interest in outsourced services. UK corporates are shifting more and more internal spending towards external sources.

Italy: poor order books

The Italian market has been losing momentum since 1992, when growth fell to 2.3% from 1991's 5.8%. In 1993 overall growth reached a rate of -0.3%. Improvement will not come until 1994, when the market is forecast to recover slightly to 1.9% growth. Major factors behind current poor expectations are low levels of forward orders in general and paralysis of IT acquisitions in the public sector.

Spain: slow recovery after sharp decline

After double-digit expansion for several years, Spain has recorded two consecutive years of negative growth: falls of 1.2% in 1992 and 3.0% in 1993. Improvement should come in 1994, with growth predicted at 3.9%. Recession hit Spain's IT sector during its transition to a more mature and sophisticated structure. The worsening economy casts a shadow over prospects for this market.

Other countries

IT markets in the EFTA region and Denmark regained some of the growth lost in previous years. However, economic dependence on Germany could weaken their recovery. Combined growth of the EFTA IT markets was 4.8% in 1993. They are forecast to grow by 4.3% in 1993. Benelux IT markets, too, might suffer due to their dependence on trade with the German-speaking markets. Double-digit growth continues in Portugal and Spain. Despite recession, Ireland's market has remained strong.

Dynamics by product segment

1993 did not see growth spread evenly across all segments of Europe's IT industry. Expansion opportunities increasingly lie in software and services, rather than traditional hardware markets.

Hardware: awaiting return of growth

Hardware revenues declined by - 2.4% last year. Moderate growth of 1.3% looks likely for 1994. Both positive and negative factors are shaping current demand trends for hardware products.

Main negative forces are:

- Recession, which has frozen corporate investment plans for IT hardware.
- Downward pressure on prices, exerted by heightened competition, increasing commoditisation and lack of product differentiation.

Main positive factors include:

- Emergence of new markets such as the small office/home office (SOHO), comprising business and consumer buyers attracted by falling prices.
- Rising demand from the traditional business market for more processing power and performance. Corporate users are seeking to run either more powerful software, or distributed end-user applications, or both.
- On the positive side, several favourable events have also brought unit growth at the desktop level. The most significant are extensive new product announcements and downpricing, accelerating demand for hardware upgrades and take-off of alternative channels. However, price falls offset the high volume growth.

As a consequence the following trends are emerging in the hardware market:

- A sharp drop in the multi-user system business, especially large and medium-scale systems. Driving the fall are reduced IT investment programmes and accelerating price declines. Also the reeningeering of business processes favours use of smaller systems.
- Slight unit growth in midrange system shipments, driven by increasing popularity of distributed computing and aggressive marketing campaigns. Nevertheless, competition from PC server architectures and PC LANs put strong pressure on prices.
- Significant growth in unit demand for personal computers, especially in UK and Germany. The PC segment's price/volume profile is changing. Price falls are slowing. This in turn is weakening demand from Europe's highly price-elastic replacement market. The prospects of stable pricing from the chip manufacturers justify expectations of slower price erosion, at least for the next year or so. Meanwhile, the emergence of new market segments is increasing both the number of PC users, and the ratio of PCs-per-user. One new product type might dramatically increase the penetration of PC and digital communications technologies. This is the PDA (personal digital assistant). Both US and European suppliers launched models in 1993, forecasting a potential mass market for the handheld devices. Here, PDAs will benefit greatly from new pan-European digital communications standards.

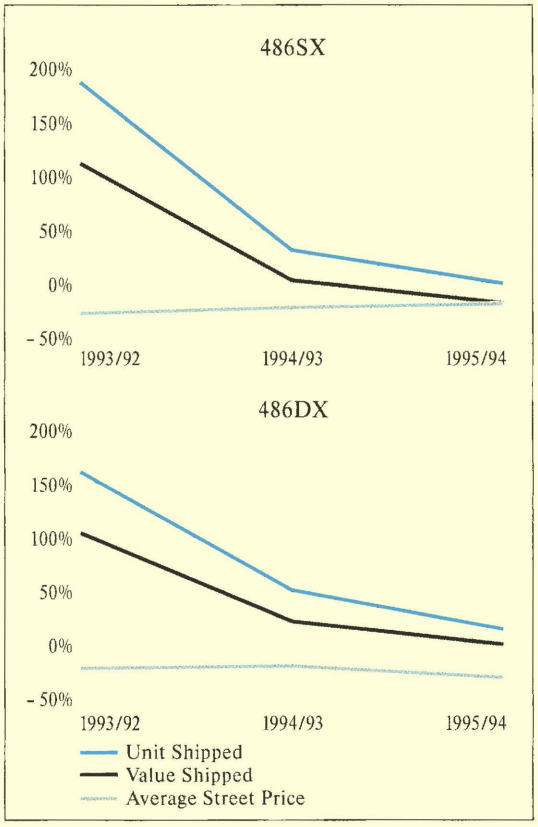


Figure 7
Western European Personal Computer Market.
486 Based Systems. Unit, Value and Price Growth Comparison

- Continued sluggishness in the office equipment market. There, new sales generated by replacement life-cycles in photocopier technologies have not offset generally low demand from the segment. These technologies include colour copying, network interface chipsets and four imaging techniques (photographic, electro-photographic, thermal transfer, Ink-jet).

Software products: strong upward trend

Software products are among the strongest drivers of European IT market growth. The market grew by 7.0% in 1993 and is set to grow by 7.2% in 1994.

However, despite strong positive trends, this market cannot escape downward price pressure. Most important positive factors are:

- rising use of graphical user interfaces, local area networks, system management software and middleware software;
- spread of personal software users in the enterprise, relying on sophisticated applications to perform sensitive business tasks;
- growth of suite marketing and bundling for desktop software. This is increasing volumes faster than revenue growth;
- uptake of more cost-effective application development tools, such as CASE tools and 4GLs;
- steady increase in the number and functionality of distributed software products;
- reduced levels of software piracy due to strong action by anti-piracy bodies.

The negative side features both demand and supply forces. Hardware price drops have brought expectations of similar price cuts on software. Suppliers are answering these with new licensing schemes designed to cap software costs. Desktop software vendors are pursuing aggressive trade-in policies.

Services: a European strength

IT services are another high-growth opportunity for European suppliers. Notable bright spots are professional services (growing by 6.6% in 1993) and network services.

Positive factors driving growth in this segment include:

- spread of business process reengineering;
- increasing demand for consulting services and systems integration;
- increasing use of outsourcing and facilities management services.

Again, this segment is seeing price competition and user caution holding back growth. Significant trends are:

- declining demand for custom programming services; they are suffering from increased use of modern software development tools and off-shore programming services;
- increasing user demand for fixed price contracts;
- increasing number of suppliers competing for market share, alone or through alliances;
- high dependence of services revenue on large long-term contracts that increasingly risk postponement or cancellation.

The market for network services contrasts sharply with the growth level of services in general. This sector includes managed network services, such as EDI and electronic mail services. It grew by 13.3% in 1993, with 12.2% forecast for 1994. Those figures place network services among the fastest growing segments of the entire IT market.

This is not surprising. The network is becoming the core utility of most user organisations. Organisational needs are combining with complex communications systems to produce:

- growth of traditional and new integration services, ranging from network design and implementation to multivendor integration, training and remote support;
- significant expenditure increases on switched data services; they include packet-switched data networks, circuit-switched services, value-added networks, virtual private networks, frame relay services and ISDN; these managed network services offer a more flexible and less expensive way to build enterprise networks than traditional leased lines;
- changed attitudes among users because the outsourcing option is available.

Support services: hit by hardware weakness

The market for support services mirrors the general decline of the systems hardware market. It recorded a flat 0.6% in 1993 and is forecast to grow 0.9% in 1994. Single-source contracts are the only growing segment within third-party maintenance.

This performance results from the following trends:

- Maintenance revenue from proprietary hardware is falling as large systems suppliers drop support prices.
- Vendors have extended guarantees and improved services.
- Multi-vendor hardware support promising better opportunities than proprietary mainframe support. However, the market is still small. It is enjoying double-digit growth from a tiny base.

Trends by vertical market

Global recession has hit IT budgets throughout Europe. However, expenditure growth shows marked differences in specific vertical markets.

For example, the banking world and manufacturing industry have different methods and frequency of buying services. Banks are using new external services to bring down the high cost of data centre operations and technical support. Manufacturing industry has smaller data centre staffs. But its development and systems support groups are much larger, maintaining its many custom applications and protocols. So cost-

Table 6
European IT Expenditure Trends by Vertical Market, 1993/92

	Total expenditure %	Outside services %	Packaged software %
Banking	3.8	4.5	10.0
Insurance and other finance	3.3	6.1	11.1
Discrete manufacturing	0.6	3.9	8.3
Process manufacturing	1.2	7.1	21.1
Health care	- 3.0	2.9	4.0
Business and other services	4.6	5.9	10.4
Transport/ communic./ utilities	1.1	5.8	10.4
Retail	1.7	9.5	20.1
Wholesale	0.1	5.3	12.9
Government	2.6	5.5	12.3
Education	4.2	5.2	14.8
Other	5.0	- 3.0	2.1
Total	**2.3**	**5.9**	**12.3**

cutting efforts in manufacturing concentrate on using internal skills for higher value-added activities. Tactics include outsourcing software maintenance, buying external software or using more efficient software development techniques.

Highest expenditure growth occurred in business services, banking and education. The biggest fall came in health care. Manufacturing, retail/wholesale and public expenditure (except education) grew less than the European average.

The growth rate in purchase of outside services was triple the rate in total IT expenditure. Services expenditure grew strongly in retail, insurance and other finance, process manufacturing and business services.

The growth rate in software purchases was double the rate in services. Retail and process manufacturing showed the biggest jump in demand for software. Education and government sales had strong steady growth.

1.2.2. Telecommunications (TLC) Market Trends

The European market for telecommunications showed healthy growth of 6.2% in 1993, reaching a total value of ECUs 141 billion.

User spending on communication products and services outpaced expenditure on information technology. This trend is likely to continue, as major areas of opportunity emerge in wide area and local area network services. Their share of users' budgets is increasing at the expense of the hardware share.

The transition towards a Community services market open to competition is being accelerated by the European Commission's Open Network Provision (ONP) directives. Based on Articles 100 and 90 of the Treaty of Rome, the ONP directives address the need to create conditions of access to fair, compatible telecommunications infrastructures.

ONP will define technical interfaces, conditions of use and price policies which are transparent and non-discriminatory for all operators, being based on objective criteria.

ONP covers the following services (for all of which studies are in progress and some recommendations await definition):

- rented lines, both analogue and digital;
- packet switched data transmission (X.25);
- ISDN;
- voice;
- network management;
- radio telephony and paging;
- intelligent network;
- MAN (metropolitan area network);
- local loop.

There will not, in principle, be any restriction on the use of infrastructures. However, the following "essential requirements" will be preserved and must be guaranteed:

- network safety;
- maintenance of the infrastructure as a whole;
- inter-workability of services;
- data protection.

Trends by country

Growth in the European communications market follows a complicated pattern. All countries have industries with a history of national regulation and protection. There is little agreement on joint industry policies or common regulation for the future.

Each European country is travelling at a different speed towards the telecoms policy goals set by the EU authorities. However, all countries feel the need for custom telecommunications policies to serve the special interests of their markets. So here we consider telecommunications policy as well as market trends.

The three major markets in Europe – United Kingdom, France and Germany – are setting the patterns.

United Kingdom: Europe's regulatory test-bench

United Kingdom policy grows from the belief that competition cures all problems and serves the best interests of all parties in the long run. Tariffs in the United Kingdom follow an advanced pattern favouring cost-based pricing. Basic data communication services are relatively expensive. The government's longterm deregulation policy affects all aspects of the telecommunications market. This has been a challenge to any player lacking experience of competitive markets. In comparing overall demand and supply factors, the UK comes out well. It is a deregulated market with intense competition. It has a high level of IT penetration and sophisticated users. The upturn in business outlook and the IT market will further increase the UK's competitiveness.

	1993 Value	1993 %	1993/92 %	1994/93 %
EU	122	87	6.2	6.5
Germany	36	26	8.0	8.1
France	22	16	6.4	6.8
UK	21	15	3.1	3.3
Italy	18	13	7.0	7.0
Spain	10	7	4.4	6.0
Other EU	15	11	6.6	6.2
EFTA	19	13	5.7	5.5
Western Europe	141	100	6.2	6.3

Table 7
European Telecommunications Market Consumption by Region: Percentage Breakdown and Growth Calculated on Market Values. Billion ECUs

The telecommunications market grew by 3.1% in 1993 and is forecast to grow by 3.3% in 1994.

France: advanced technology, conservative regulation

French policy is in many aspects the opposite of the UK. This market wants to introduce telecommunications reforms at a much slower pace. The French administration believes that gradual adjustment to competition – as a user market for telecommunications and as a supplier market of services and equipment – is best for all parties involved. The result is that the liberalisation process is among the slowest in Europe.

Nevertheless, the French market can boast advanced features. France is leading Europe in rolling out digital network technology. Together with Germany, this market is a driving force behind ISDN in Europe. Many value-added services have a high penetration in France, including enhanced fax and X.400 networks. In the cellular services arena, conservative policies have saved this market from the problems faced by the UK and Sweden. Too many small networks and a lack of standards are preventing those countries from making efficient use of scarce radio spectrum.

The telecommunications market grew by 6.4% in 1993 and is forecast to grow by 6.8% in 1994.

Germany: unification slows liberalisation

Germany is Europe's largest market for telecommunications representing some 26% of European total.

In 1992 Germany was one of the fastest growing markets, due to heavy telecoms investment in the new federal states. However, in 1993 this investment effort stopped growing. Spending levels for investment in equipment are likely to remain flat during the middle of the 1990s.

Thanks to a stronger dynamics in telecom services, in 1993 the market recorded 8% growth, and looks forward to the same rate of growth in 1994. Germany is forecast to take a 27% share of the European market by 1997.

This strong trend comes despite complaints from corporate users. Tariffs remain high in Germany. Large companies operating in the Federal Republic complain that the regulatory regime forces them to source from Deutsche Telekom.

Bonn has asked the European Commission for an exemption from the 1998 deadline for voice deregulation. Officials say Telekom needs the delay so it can more easily raise capital to fund its unification investments.

Italy: rushing to improve further

Italy is Europe's eighth largest market, with a share of 13%. Italy shows one of the lowest rates of penetration in both lines and digital technology. Nevertheless, growth expectations are good. The market expanded by 7% in 1993, and is expected to increase by the same rate in 1994.

Fast growing segments included mobile voice equipment and services. Italy also enjoys some advanced data services, which are open to competition, and advanced voice services.

The Italian authorities are considering a major restructuring of the country's large state-owned telecoms sector.

Spain: fast growth forecast

Spain's communications market is still underdeveloped for the size of the country. Deregulation is relatively slow. The infrastructure is poor both in size (low number of connections) and quality (low digitalisation).

The market grew by 4.4% in 1993 and is forecast to grow by 6% in 1994.

However, longterm forecasts for European telecoms markets give Spain the number two position for growth, and number three for size of telecommunication investments. Spain is not an attractive market for advanced data services yet. Nevertheless, the high penetration of data communication connections is a positive indicator that this market will develop well.

Other countries

Among the other countries, Portugal, Switzerland, Austria, and Norway are experiencing stronger growth. Denmark and Greece stand out for their bright telecommunications markets. Ireland, Sweden and Finland are among the countries still experiencing a dip.

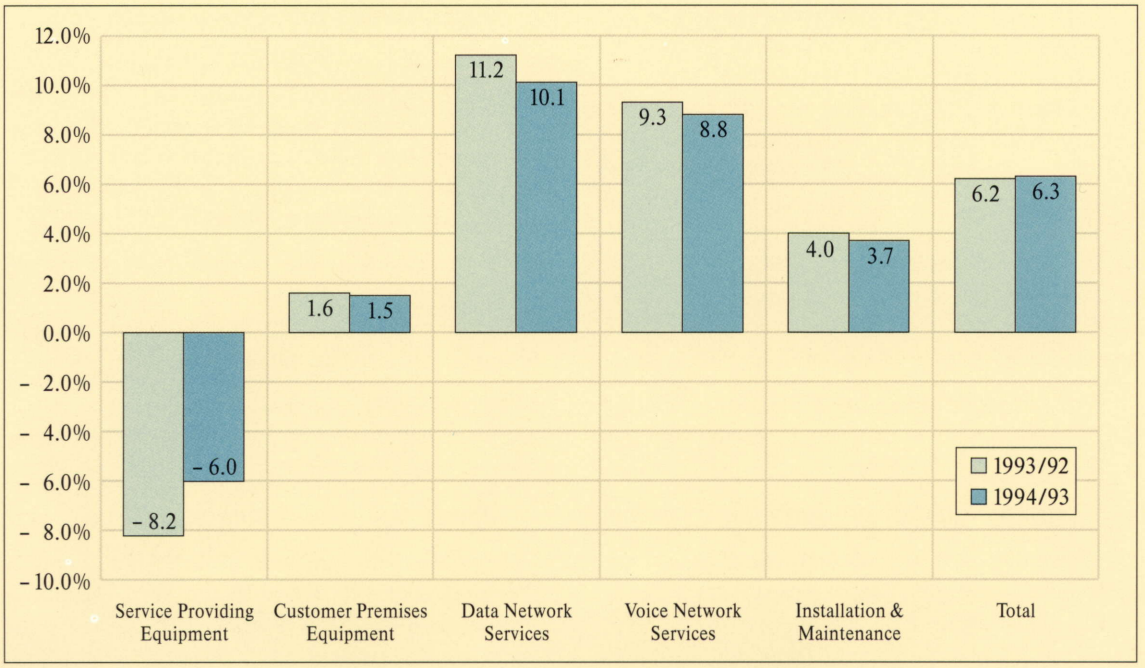


Figure 8
Western European Telecommunications Market Value Growth by Product Segments

Trends by product segment

The fastest growing segments of Europe's communications market are wide area network services, LAN services and mobile equipment. Spending on LAN services increased by 27%, and on mobile services increased by 31% in 1993. Mobile equipment grew by 17% last year.

Growth in the data communications and telecommunications segments was much slower. Spending on these products and services increased by 6% and 5% respectively in 1993.

The two different growth trends highlight the movement away from traditional data communications solutions to local area network technology and distributed computing. Falling unit values for hardware are also a factor.

Communication equipment: islands of fast growth

Major growth opportunities in the customer premises equipment segment come from:

- products incorporating new technologies, such as ATM and Frame Relay; today, however, volumes are still very small;
- users moving to mobile access; this trend is making the market for mobile equipment - carphones, cordless phones, handhelds - an island of fast growth in the otherwise slow voice equipment segment; technologies such as GSM and PCN will bring further expansion of this sectors.

Older product types - such as modems and X.25 equipment - show little sustained growth. Only a few new products, such as V32bis modems, move against the trend.

The equipment market for service provision is declining (- 8.2% in 1993), as price erosion and discounts reduce the product segments.

Table 8
European Networking Expenditure Trends (Hardware, Software and Services) by Vertical Market. 1993/92

	Networking expenditure %
Banking	12.8
Insurance and other finance	19.3
Discrete manufacturing	11.5
Process manufacturing	15.2
Health care	4.6
Business and other services	14.7
Transport/communic./utilities	10.4
Retail	20.8
Wholesale	8.2
Government	8.7
Education	15.0
Other	- 2.0
Total	**13.2**

Active promotion of digital leased lines by European PTTs will favour shipments of TDM E1 multiplexers, which are forecast to show a strong growth. Spending on ISDN equipment will also grow significantly, reflecting the move to ISDN as a wide area solution in some European countries.

Overall the communications equipment market declined by 4.7% in 1993 and is forecast to decline by 3.2% in 1994.

Voice network services: big potential in mobile

The market for voice network services totalled ECU 93.7 billion in 1993, making it by far the largest communications segment. The market grew by 9.3% in 1993, masking a difference between business spending (high growth), residential spending (average growth) and spending on international voice services (high growth). The major area of opportunity lies within mobile voice services, which the EU has liberalised.

Installation and maintenance: battle for the LAN market

The installation and maintenance market grew by 4.0% in 1993. It is forecast to grow by 3.7% in 1994.

Services and support capabilities are important to distinguish factors for communications equipment and LAN vendors, as increasing competition puts pressure on pricing and marketing-mix policies.

The growing size of networks and the increasing sophistication of network operating systems make LAN maintenance and support services the highest growing niches in the market.

Trends by vertical market

Our analysis of communications expenditure by vertical markets focuses on networking hardware, software and services bought by business and public users. It does not consider spending on voice services or expenditure of domestic users.

Networking expenditure is growing fastest in the retail, insurance and other finance sectors. Significant growth is also occurring in process manufacturing, business and other services, banking and education. Network spending is well below average in discrete manufacturing and transport/communication/utilities. Demand is least dynamic in government, education and health.

1.3. Europe as Consumption Area

1.3.1. DP Penetration

The national IT markets of Europe have followed different patterns of development. So it is difficult to generalise about IT adoption in the region.

IT development, of course, reflects each state's broad industrial evolution. Countries where industrialisation came first generally have higher productivity through heavier investment in high technology over a long period. Thus Germany, France and the UK have traditionally led Europe in adoption of IT. They have been overtaken only by countries, mainly in the Nordic region, using industrial policy to speed up IT usage.

By contrast, the pace of IT uptake in more recently developed European countries is a question of reducing the technology gap between their own industries and those of the most developed states.

Intensity of IT penetration

Between 1982 and 1992 the Scandinavian countries led Europe in IT adoption. These markets have seen the level of IT penetration (the ratio between value of IT expenditure and value of GDP) almost triple, reaching ratios between 2.6% to 2.7% of GDP. Finland is the exception, reaching a ratio of 2.0%.

Switzerland and the Netherlands have followed a similar development trend. In these countries penetration levels relate to the structure of the economy itself, rather than industry policy. Both countries have powerful finance and services sectors. These areas have led in adoption of IT over the past ten years.

Germany, France and UK – historically the most advanced countries – have slightly more than doubled their IT penetration, reaching levels between 1.9% and 2.4%.

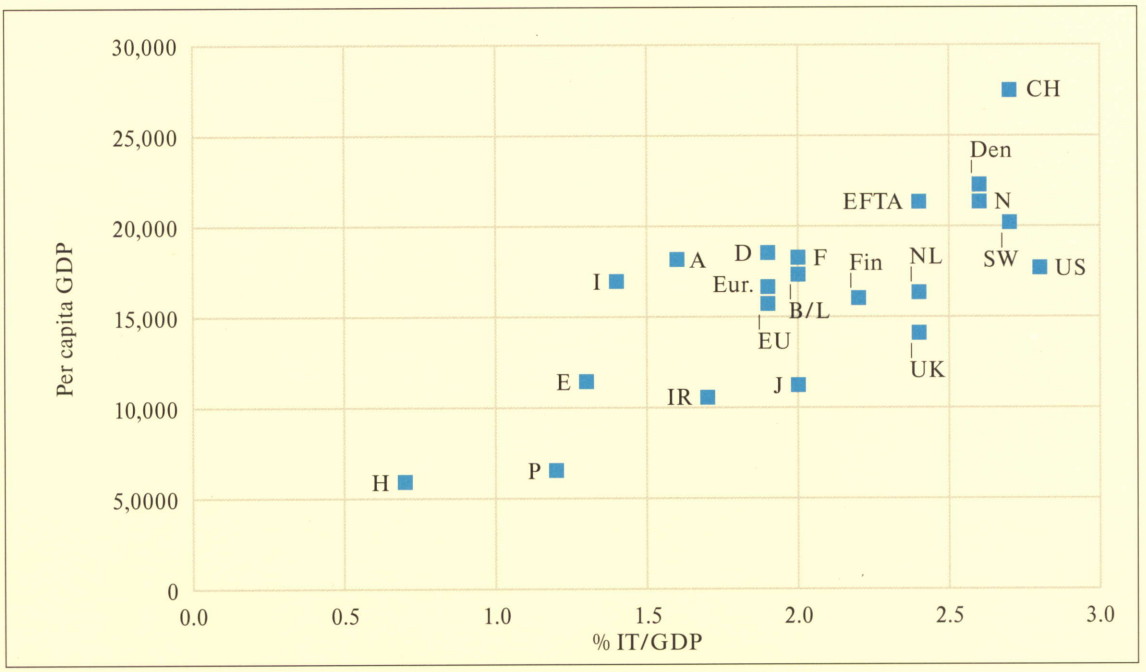
The countries in which IT penetration was less than 1% in 1982 (Italy, Spain, Portugal, Ireland) have also seen big increases. Their IT penetration levels have risen to 1.2% – 1.7%.

General economic problems – lack of demand and rising interest rates – have weakened the traditional drivers of IT penetration. IT adoption has slowed in all European countries over

	IT/ GDP %	IT per Capita ECUs	White Collar per Screen
Europe	1.93	313	1.8
EU	1.88	295	1.8
EFTA	2.35	501	1.8
Germany	1.94	361	1.6
France	2.00	362	1.8
UK	2.41	340	1.9
Italy	1.35	227	2.1
Spain	1.25	143	2.1
Austria	1.61	293	1.7
Belgium/Luxembourg	2.20	353	1.7
Denmark	2.60	554	1.4
Finland	2.02	351	1.6
Greece	0.73	43	2.5
Ireland	1.71	181	1.7
Netherlands	2.36	387	1.8
Norway	2.71	547	1.5
Portugal	1.20	79	2.5
Sweden	2.59	574	1.8
Switzerland	2.65	730	2.3
US	2.83	501	1.2
Japan	2.04	229	4.3

Table 9
IT Penetration by Country, 1992. ECUs

Figure 9
IT Penetration by Country, 1992



the past few years. 1992, in particular, saw a fall in IT market growth steeper than the decline in GDP growth. As a result, IT penetration has suffered a setback Europe-wide. A clearer picture comes from looking at European countries ranked by level of economic development.

Figure 9 confirms that there is a general correlation between:

- the level of development of a national economy (measured by the level of per capita GDP, plotted on the Y-axis) and
- the level of IT penetration (measured by the ratio of IT expenditure value to GDP value, plotted on the X-axis).

The upper right side of the chart shows that countries with higher levels of GDP per capita also have higher levels of IT penetration. In the middle stand the three major economies with high historical IT intensity. Towards the bottom left are the later developing economies at lower levels of both wealth per capita and IT usage.

Despite a level of penetration far behind the more advanced countries, Italy and Spain show strong growth in IT expenditure, as a whole and per capita. Distortions are present due to inflation increasing the value of GDP and therefore weakening the ratio of IT penetration. Nevertheless, some European countries still have room for growth as they are far from reaching IT saturation.

Structure of IT penetration

Penetration rates are not the only evidence that Europe is many IT markets in one. Another source of national peculiarities is market structure: the distribution of expenditure between hardware on one side, and software and services on the other.

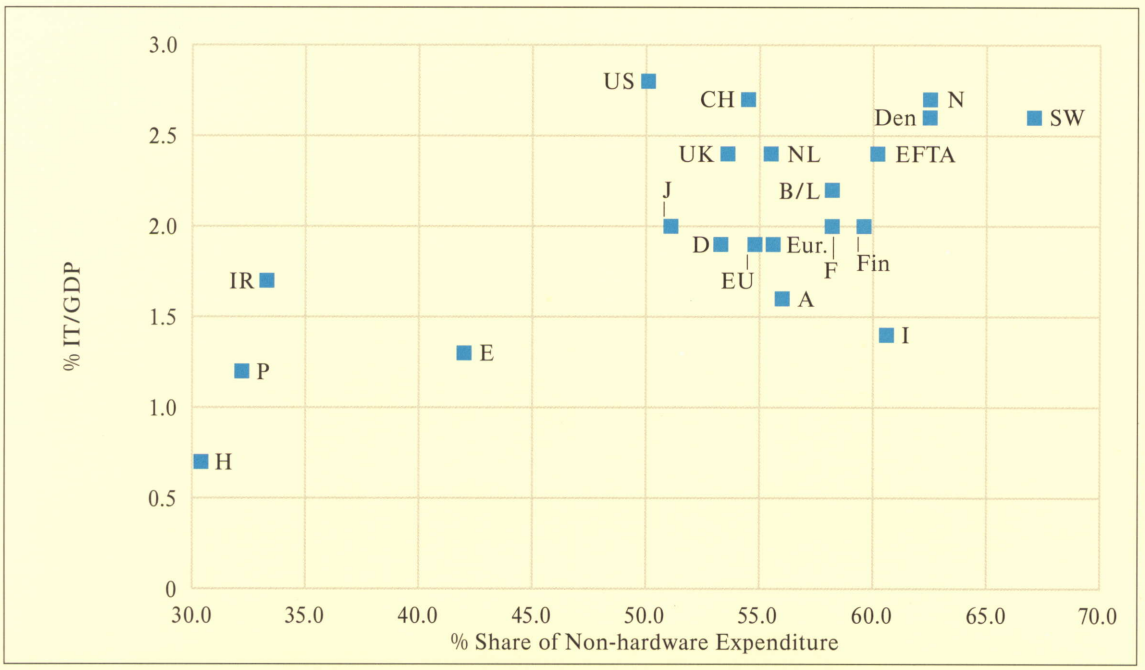


Figure 10
IT/GDP versus Share of Non-hardware Expenditure, 1992

Market structure has changed radically in the past decade. The share of IT expenditure won by software and services has gradually overtaken the share for hardware. In 1993 it represented some 61.3 % of the overall European IT business.

Increasing penetration of IT has led to more sophisticated purchasing. However, at a certain point the correlation between higher IT penetration and larger shares for software and services begins to weaken.

Take for example *figure 10,* plotting the relationship between the IT expenditure/GDP ratio (Y-axis) and share of non-hardware expenditure. The difference between Spain and Sweden is clear. However, high increases in per capita IT expenditure generally bring only slight increases in the share of software and services.

Moreover Italy, with a low level of IT expenditure per capita, has a share of non-hardware business as high as the most developed countries. On the other hand Switzerland, which is as IT intensive as the Scandinavian countries, lags far behind them in share of non-hardware business.

This evidence suggests that as users become more sophisticated and IT-aware, they spend more on applications and services to increase the utility of their installed investment. However, the analysis also shows that there is no critical expenditure level at which users start to focus on non-hardware purchases.

Instead, spending on software and services remains dependent on factors such as:

- desire to get more productivity from IT investments;
- evolution of IT as a way to integrate organisational and finance processes;
- challenges facing MIS managers, such as cost control.

Deep price-erosion of hardware products – especially personal computers and open systems – has also helped move the balance of user budgets towards non-hardware expenditure.

Concentration in the IT market

Concentration of the European IT market has decreased significantly over the last decade. Turbulent times for both industry and market have led to new behaviour patterns and competition rules.

Many IT leaders have changed their business models under pressure from single-digit growth rates, technology downsizing and hardware commoditisation. They have diversified into the provision of solutions. Or vendors have adopted a bipolar approach, treating their hardware and software businesses separately from their services and solutions businesses.

On the user side, restructuring has been dramatic. Major corporations are facing worldwide recession, lack of productivity and pressures to improve co-ordination of internal resources. These forces have pushed IT buyers towards new options, such as outsourcing and systems integration. They are measuring IT investment returns by new criteria. Today buyers demand that their MIS functions create competitive strengths in the marketplace.

IT vendors are finding inadequate the traditional product marketing techniques and business models based on vertical integration. These commercial strategies have caused established IT giants to lose market share to a new breed of more specialised companies.

The top five vendors, who held slightly more than 50% of the market in 1982, took only 36% in 1992. Sharpest declines in combined top five market share came in Sweden, Switzerland, Belgium, and Denmark. Of course even this reduced level of IT concentration is high compared to other industries.

Again, the overall European figure hides big national differences in concentration. These variations stem from differences in the rate and structure of growth, plus some peculiarities of IT customer attitudes.

A rough measure of these differences comes from the number of companies whose combined market share accounts for some 40% of the national demand for IT. (Figures are for 1992, data-processing sector only, excluding office products.)

Number of Supplier Companies	
Italy	2
Austria	3
Greece	4
Finland	4
Ireland	4
Germany	4
Portugal	4
Denmark	5
Norway	5
Spain	5
Netherlands	6
Europe	7
Belgium	7
Switzerland	7
France	8
Sweden	9
UK	9

The table highlights three market groups based on the strength of IT vendor concentration.

i. *Countries with the highest rate of concentration:* Italy, Austria, Greece, Finland, Ireland, Germany, Portugal.

These markets have the following features:

- Ratio of IT penetration to GDP is at or below the European average.
- Level of per capita IT expenditure is among the lowest.
- A market leader and another strong company share the top two positions.
- The share held by software and services varies among this group (Germany is slightly below average, while Finland and Italy are above average).

ii. *Countries with a rate of concentration:* Denmark, Norway, Spain, Netherlands, Belgium.

Market characteristics here include:

- The IT penetration rate is higher than GDP growth. The exception is Spain, which has the lowest rate of IT intensity in Europe. Per capita IT expenditure is above average (again with the exception of Spain).
- The market leader does not score a share much better than the European average (19.9%). Only in Spain is the position of the market leader far stronger than average.
- Norway is a special case. There, a strong local vendor can counter with equal market power the top leading vendor, who has the lowest top market share in Europe. But the two together do not account for more than 22% of the national IT business.
- All record higher than average concentration of IT expenditure on hardware. The only exception is Spain, which has the highest non-hardware share in Europe's IT business.

Spain falls in this segment despite a low development rate which makes it closer to the first group of national markets. This is due mainly to its lack of strong local suppliers with competitive benefits coming from market recognition or traditional expertise in vertical markets.

iii. *Countries with the lowest rate of concentration:* France, UK, Switzerland, Sweden.

These markets have the following features:

- IT penetration rates are slightly above average (France, UK) or far above average (Switzerland, Sweden).
- Per capita IT expenditure differs widely. Sweden is far higher than the European average, whereas the UK is much lower. Sweden and Switzerland record the highest levels in Europe.
- In France and UK, the market leader is not as strong as elsewhere in Europe. Local companies are even weaker, holding slightly more than half of the leader's business. That compares to the two-thirds ratio in Italy and Germany. In the other countries, the rate of concentration and the leaders' positioning are among the lowest in Europe.

1.3.2. TLC Penetration

Growth, competition and privatisation are today's watchwords in the communications market.

However, unlike the IT market, the equipment infrastructure of the communications environment varies by country. So European TLC markets are unlikely to develop at the same pace.

Intensity of communications penetration

Differences in the number of residential telephone lines are still significant. Of the seventeen West European countries, three (Spain, Portugal, Ireland) have fewer than 35 exchange lines per 100 people. Portugal is the lowest, with 27 lines per 100. Sweden and Switzerland top the European league with 67 and 60 lines per 100 inhabitants respectively.

Table 10 Communications Penetration by Country

	Communications Investment/GDP %	PSTN lines per 100 inhabitants	Mobile Connections per 1,000 inhabitants	% Digitalisation	Leased lines per 100 screens
Europe	0.7	45	12	58	7
Germany	0.8	41	7	85	4
France	0.4	51	7	80	7
UK	0.4	45	21	48	12
Italy	0.7	46	10	41	9
Spain	1.1	34	3	34	5
Austria	0.9	43	15	30	5
Belgium/Luxembourg	0.4	41	5	40	13
Denmark	0.3	58	31	34	7
Finland	0.6	54	63	90	10
Greece	0.8	41	1	6	2
Ireland	0.3	29	9	69	4
Netherlands	0.5	48	8	79	5
Norway	0.4	51	55	45	4
Portugal	1.0	27	1	25	4
Sweden	0.5	69	66	47	7
Switzerland	0.9	60	26	40	8

Source: EITO, OECD

Between the two poles, France and the other Scandinavian countries have a teledensity of around 50 lines or more. Most other countries are close to the European average of 45 lines per 100 inhabitants. Among the top five countries, the teledensity of Germany is closer to the level of Spain than to France. While the UK and Italy are near the European average.

Teledensity correlates closely with national wealth. By contrast, the intensity of communications investment – measured as the ratio between communications investment and GDP – varies country by country. It has no correlation to teledensity or national wealth.

The countries with the most intensive investment in communications are Portugal and Spain, which need to catch up in development of IT infrastructure. Switzerland and Austria also lead in ratio of communications expenditures to GDP.

Among the bigger countries, Germany is investing massively to bring its eastern region up to western levels. Italy also has an ambitious investment programme. UK and France are below the European average in levels of communication investment as a percentage of GDP.

New technology penetration

The following indicators are important for measuring the quality, or value-added, of communications infrastructure:

- Digitalisation: This is an essential foundation for advanced network services.
- Penetration of mobile connections: This is a positive indicator for maturity of the market and development of advanced voice services.
- Ratio of leased lines to screens: This is an important factor for development of advanced network services among workers with access to computerised information.

The contrast is as stark between countries within a region as between the most developed and less developed regions. This results from differences in level of liberalisation, economic structure and pricing policies. A significant economic factor is the strength of telecom-intensive vertical sectors.

Sweden and the other Nordic countries have the highest penetration of mobile connections. Italy, despite being number two in market size, has not reached the European average in mobile. However, together with the UK, it outperforms Germany and France. The UK has triple the level of mobile penetration found in the other two markets.

The leader in public network digitalisation is Finland with a 90% rate. Closely following are Germany and France. Also well advanced are Ireland and the Netherlands. In contrast, the rest of Scandinavia, Italy and the UK have not yet digitalised at least a half of their connections.

The leaders in the ratio of leased lines to screens are Belgium/Luxembourg and the UK, with more than 12 leased lines per 100 screens. Finland and Italy follow close behind. Rates of penetration in Germany and Spain are among the Europe's lowest, while France equals the European average.

1.4. Europe as Production Area

1.4.1. Information Technology Employment, Manufacturing, R & D, Investments

In 1993 the IT industry employed some 1,000,000 people or 1.8% of the European workforce. Some 310,000 people were employed in the data processing and office machinery segment, some 280,000 in the software and services segment, and the rest in the many companies operating in distribution. Large enterprises employ approximately 85% of the IT workforce. However, some 75% of IT enterprises in Europe are categorised as small.

Location of IT manufacturing plants in Europe closely reflects the employment environment and culture strengths of individual countries.

Because of geographic position and language, the UK and Ireland have long been good stepping stones into other European markets for US hardware, software and services companies. They have maintained their attractiveness through national aid for investors and tax relief schemes. EU funds for developing high-tech industries in targeted areas have also helped.

The statistics available show that of 60 data processing and office machinery companies employing more than 500 employees in Europe, 19 are in the UK and seven in Ireland.

The UK's most important IT investment area is Scotland. The first US IT manufacturers located European production there in the 1950s, thanks to government and local grants. Current estimates show that Scotland makes some 25% of all PCs sold in Europe.

Ireland is developing particular strength in software. It is now attracting software design centres, as well as the packaging and distribution facilities of overseas companies. Among Ireland's assets is a pool of technology-literate graduates and skilled labour larger than the European average. As a result, the country produces around 40% of PC software sold in Europe.

Germany hosts the second biggest number of IT manufacturers, with 18 companies. Plus points for production include its position in the centre of Europe, and its role as Europe's largest domestic market. The main IT manufacturing area is Bavaria.

The Netherlands has 12 IT companies employing more than 500 people. The country offers Europe's biggest harbour and one of its most developed financial markets. The Netherlands is a particularly attractive location for IT packaging and distribution operations.

In Italy, nine IT companies employ more than 500 employees. EU and national policies promoting high-tech investments have made Italy's costs of capital and labour comparable to or better than other regions.

France has only 5 large IT companies. This is a significant number compared to most other European countries, but low compared to the major national economies. The emphasis of France's public policy is very much on creating the right environment for companies to carry out R&D, as well as manufacturing. Science and business parks have sprung up to attract high-tech companies. Europe's biggest science park, Sophia Antipolis in southern France, is home to some 180 companies and 5,500 employees involved in computers or electronics. The national and local authorities offer these companies tax breaks, incentives for each job created and grants towards purchase of capital equipment.

The severe recession and restructuring by IT players are bringing changes to the structure of IT manufacturing and employment in Europe. The following trends are at work:

- Major US systems vendors are rethinking their past strategy of having similar manufacturing and R&D structures in the triad regions (North America, Europe, East Asia). As they rationalise their production networks, only plants and R&D centres generating strong returns are surviving. The rest are being closed or switched to new product types.
- European vendors are rationalising the production of traditional hardware. They are putting increasing focus on R&D, design and logistics. Manufacture and assembly of their products are moving to lower-cost regions, especially East Asia.
- European, US and Japanese players are opening or extending plants in Europe to supply products based on emerging technologies to the mass market. An example is ink-jet printer production.
- The larger Taiwanese companies have based their global strategies on longterm OEM deals, especially in the PC sector. Now they feel the need to move assembly and sales operations closer to customers in Europe.
- Japanese companies continue to have extensive production in Europe for office equipment, particularly photocopiers. Japanese makers prefer an OEM strategy for their European presence in the computer equipment industry.

The net result of these trends in Europe is that:

- Jobs are being lost at the manufacturing stage of the value chain. But Europe needs new investment in skills and facilities to improve logistics, design new products and offer new kinds of services.

- Fixed capital investment has started to decline, having been relatively stable since 1985.
- Estimates put fixed capital investment at 4-5% of production value in the industry.
- However, the sector's investment in R & D has traditionally run at almost twice the level of its investment in production facilities. All the major IT players in Europe have maintained R & D expenditure at 7% to 9% of total sales, despite recession and poor financial performance.
- R & D effort focuses more and more on engineering middleware applications, vertical market applications and consulting services, designing new products in emerging market areas (multimedia, mobile computing, network services).

1.4.2. Localisation of TLC Manufacturing Plants, R & D, Commercial Investments, Mergers and Acquisitions, Employment

Employment, manufacturing, R & D, investments

Europe's telecommunications industry employs some 1,250,000 people, or 2.2% of the European workforce. Enterprises operating mainly as makers of communications equipment number 3,188, of which 110 employ more than 200 employees. Companies providing telecommunication services employ some 990,000 staff. They include national PTOs, managed data network service-providers and mobile services companies. The number of businesses is small due to Europe's regulated monopoly structures.

The industry is very concentrated. The top ten suppliers in the EU (all European except one) hold more than 80% of the market. The concentration rate has increased in recent years because of the switch to digital technology. This has brought a tremendous rise in development costs.

Mergers and acquisitions among equipment and transmission companies have enabled EU manufacturers to equal the size of the world's largest suppliers. Exceptions are a few specific segments in terminals (such as fax machines), and data communications (such as voice/data multiplexers).

At present seven EU companies are among the global top 15 suppliers. EU giants have maintained a truly European structure, with production plants spread throughout the Community. They fall into several categories:

- big telecommunication equipment manufacturers, especially strong in France, Sweden, Italy;
- big electronics generalists, especially found in Germany;
- small/medium players manufacturing equipment for public switching, transmission and mobile communications, which have allied to achieve critical business mass, France and Scandinavia give examples;
- large US manufacturers which have gained significant footholds in Europe, they have made strategic supplier alliances (mainly in Italy and Spain), or set up operations in the highly liberalised UK market.

R & D is particularly important for developments in switching and network infrastructure. The investments required to compete in digital technology make this industry one of the most R & D intensive sectors within telecoms. Its R & D expenditure now reaches more than 10% of total turnover.

This situation is unlikely to change. R & D demands will remain high, driven by the introduction of mobile communications, intelligent networks and advanced switching techniques for broadband communications.

Telecom operators finance a significant share of equipment R & D. The European Commission is another major R & D contractor in telecommunications through the RACE programme.

Manufacturing investments are particularly important in terminal equipment production to achieve scale and quality economies. Here competition from Japanese and other East Asian suppliers has become fiercer.

In telecommunications services, differences arise in the degree of public ownership of networks, the balance between government and commercial control and the degree of competition allowed. A number of new players have appeared offering value-added services throughout Europe. Their activity focuses mostly on non-voice transmission over private telecommunications networks.

Alliances have become more frequent in the services sector than in the equipment branch. Agreements between EU and non-EU firms continue to outnumber those between EU partners.

Due to its higher degree of liberalisation, the UK has become the telecommunications laboratory of Europe. Concentrated there are Europe's most advanced mobile and data services, harshest price competition and greatest number of competing local operators.

1.4.3. Mergers & Acquisitions in the ICT Industry

The early 1990s brought a spectacular increase in merger and acquisition activity to the IT industry. The equipment, computer, software and services sectors all took part. Objectives for the deals have included:

- acquisitions of leaders in specific countries or vertical market segments, made to broaden market access;
- long-term technology alliances, involving the acquisition of minority stakes, aiming to achieve higher R & D synergies for common core technologies;
- alliances, also involving mergers or acquisitions, designed to open new markets by providing innovative integrated products and services.

The last 18 months have seen a fall in the number of IT mergers and acquisitions. The bad economic situation has hit company liquidity and financial performance. So top managers have focused on consolidating existing activities.

Nonetheless the reduced activity has witnessed a new kind of equity partnering. Different are both the types of operators involved and the objectives of the deals. Three major types of deal have emerged in recent months:

i. The first type aims to form a new breed of hybrid company for the new markets emerging through convergence of IT and communications. The most frequent of the new M & A types, these deals have involved the largest number of players. The spread of digitalisation through IT and communications markets is blurring old distinctions between a number of traditional sectors. The old guard carriers and systems vendors of Europe and the US have become highly conscious of opportunities that might arise from this convergence. So its members are investing massively in companies offering professional services and data network services. Their goal is to achieve global market presence as soon as possible. Thus they are increasing the portfolio of services and solutions they can offer clients.

ii. The second type of partnering is occurring among telecommunication carriers. In the process of privatisation, small European PTOs favour the option of allying with an established international operator. They sell about a third of their equity and get in return management expertise, skills in emerging areas, as well as investment and marketing resources.

iii. The third type of deal is the most interesting. Announcements of such alliances have come almost daily over recent months, especially in the US. They prove that the entertainment, telephony, cable and computer industries are coming together. The focus of these deals is providing information and services to people in their homes. They involve, for example, games, movies on demand, airline schedules and financial services. The entertainment business holds the content assets. The telephone and cable businesses control the delivery mechanisms. The computer business has the key, in software, to the digital environment. These dissimilar companies face a tough challenge. They must balance the twin objectives of expanding into new markets and looking after existing customers.

Equity deals and alliances are the tools to expand into new markets. They are a way to share the development of new ventures and their related risks with leading players in different technology or services areas.

As a result, we are now seeing the spread of large entrepreneurial networks of independent companies, suppliers and customers linked by information technology, communications, entertainment services and other services expertise to share skills, costs and access to emerging markets.

1.5. Trade: EU and Other Worldwide Areas

Key features of European trade continue to be dominance of intra-European exports (that is, between EU states) and increasing dependence on extra-European imports. In the computer and office machinery segment, Europe's trade deficit was about 19 billion ECU. In the telecom equipment segment the trade balance was positive, at 252 million ECU.

Imports from the USA contribute some 17% of total ICT imports to the EU, imports from Japan contribute some 13% and imports from the Four Tigers contribute some 11%. Imports from other EU countries contribute 51% of the total, while exports to other EU countries contribute some 66%.

EFTA countries' trade has the same high dependency on non-European states for imports, and the same higher volume of exports to European states compared with other regions worldwide.

Higher mutual dependency on imports characterises trade in US and Japan. US imports come mostly from Japan and vice-versa. This pattern creates a trade deficit for the US, while bringing an export surplus for Japan. Both regions have a similar portion of exports directed towards EU and EFTA countries: 40% from US and 33% from Japan.

Table 11
Worldwide Trade by Region. Office Machines and EDP Euipment, 1992 Million ECUs

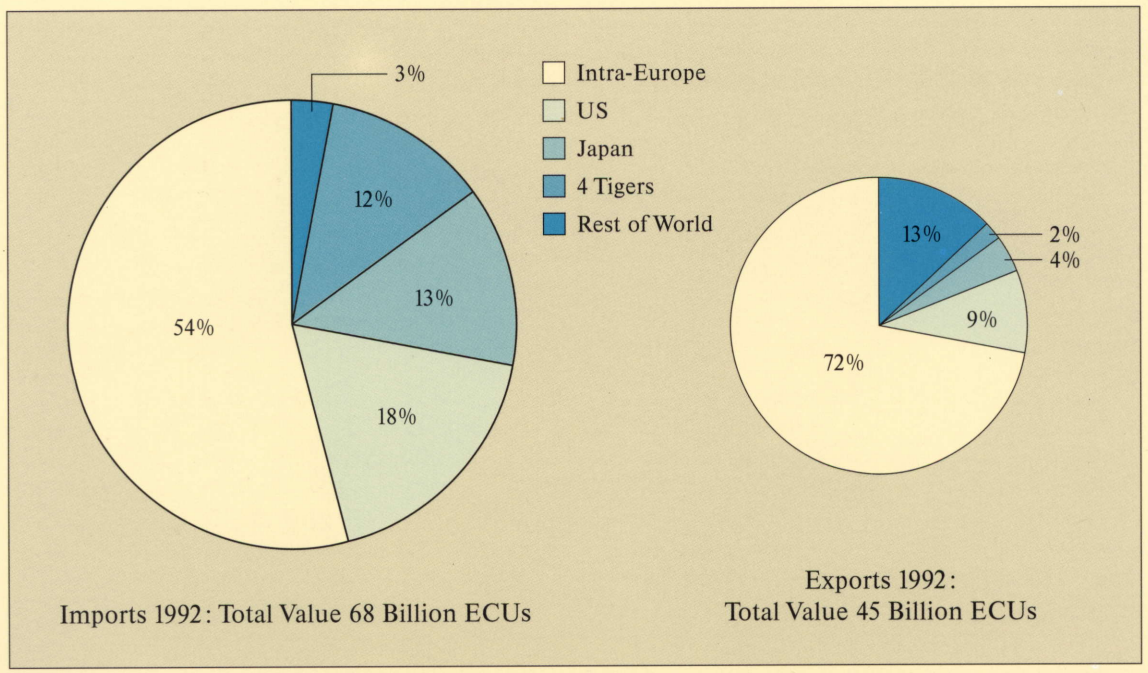
		EU	EFTA	US	Japan	4 Tigers	ROW	Total
EU	Imports	28,906	1,495	9,358	7,085	6,442	1,633	54,920
	Exports	25,264	3,266	3,296	463	477	3,132	35,899
	Trade balance	- 3,642	1,771	- 6,062	- 6,622	- 5,965	1,499	- 19,021
EFTA	Imports	3,097	264	1,782	925	818	86	6,972
	Exports	1,726	324	233	14	30	318	2,645
	Trade balance	- 1,371	60	- 1,549	- 911	- 788	232	- 4,327
US	Imports	2,718	225	0	8,657	7,604	788	19,992
	Exports	10,280	849	0	2,823	2,148	10,683	26,783
	Trade balance	7,562	624	0	- 5,834	- 5,456	9,895	6,791
Japan	Imports	488	20	2,745	0	794	1,207	5,254
	Exports	8,440	410	11,186	0	2,402	3,847	26,285
	Trade balance	7,952	390	8,441	0	1,608	2,640	21,031

Source: Eurostat

Table 12
Worldwide Trade by Region. Telecommunications Million ECUs

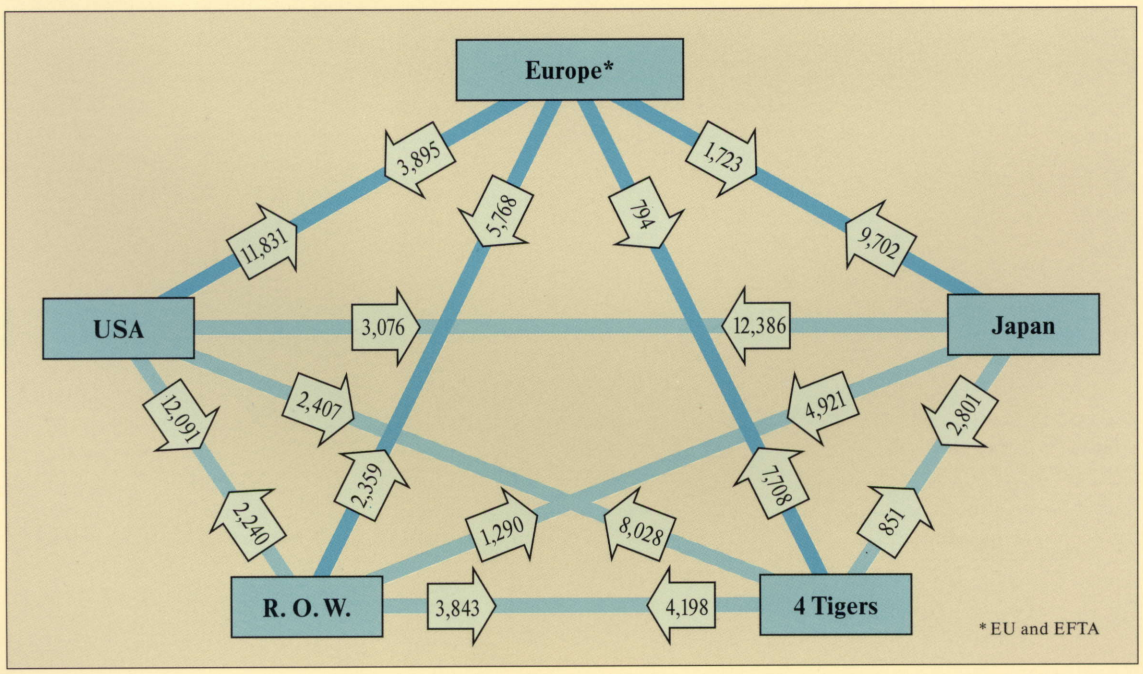
		EU	EFTA	US	Japan	4 Tigers	ROW	Total
EU	Imports	2,038	841	787	949	381	560	5,557
	Exports	2,066	520	258	1,145	242	1,579	5,809
	Trade balance	28	- 321	- 529	196	- 140	1,018.2	253
EFTA	Imports	424	254	65	142	67	81	1,032
	Exports	665	271	108	1	45	739	1,830
	Trade balance	241	17	43	- 140.6	- 21	658.7	798
US	Imports	214	57	0	1,034	424	1,452	3,182
	Exports	645	56	0	254	259	1,408	2,623
	Trade balance	431	- 1	0	- 780	- 165	- 44	- 559
Japan	Imports	13	1	288	0	57	83	442
	Exports	785	67	1,200	0	398	1,074	3,524
	Trade balance	772	66	912	0	341	991	3,082

Source: Eurostat



Source: Eurostat

Figure 11
European
Total ICT Equipment
Imports/Exports
by Region, 1992.
Billion ECUs



Source: Eurostat

Figure 12
ICT Trade Worldwide,
1992.
Million ECUs

2. Towards a New ICT Industry

2.1. The IT Driving Forces: Technological and Socio-economic Changes

Europe continues to face a period of uneven growth, despite its size, its national peculiarities and its growth potential. Economic instability, technology and competition developments, plus evolving user needs have continued to shape the market.

Looking at recent trends from a broad macro-economic viewpoint, the following factors help us to understand and better anticipate the future pattern of market growth.

Convergence between economy and market trends

- Over time the relationship between growth of Europe's IT market and the growth of European economies has become closer. For the last three years, the IT business grew more slowly in nominal terms than the economy. As *figure 13* shows, the difference between nominal percentage growth of the IT industry and nominal percentage growth of the economy has gradually reduced. It is almost zero at present.

IT and economic growth rates are converging for a number of reasons:

i. As the IT business gets bigger, its growth is slowing.

ii. The industry has fragmented into separate sectors, such as PCs and services. As a result, the structure of IT budgets has changed. Discrete and variable expenses have become more important than capital-intensive spending on mainframes.

iii. Economic downturn has frozen user plans to invest in large-scale capital assets. Investment cycles have slowed, if not completely stopped.

The major implication of the stronger link between the economy and the IT business is that economic growth relates increasingly to new initiatives with high IT components.

To succeed both in highly competitive global economies and barrier-free Europe will require tighter cost control, improved productivity, greater speed and flexibility, and an ambitious business strategy. IT will be a key component in achieving these goals.

Today European integration is slowing because of delays to certain types of projects, each of which would have had used IT heavily: for example, integrated airlines, communications and banking systems. The delay of such economic developments has hurt the IT business.

Technology surplus

Progress in primary technologies has been dramatic. *Figure 14* compares performance increases of key technologies from a base level of 1971. In 20 years (from 1971 to 1992) DRAM improvements were 16,000 fold, microprocessor improvements (in capacity and performance) were about 1,000 fold and storage about 100 fold. Looking forward, the technical community believes strongly that the constant doubling rate will continue for at least the next ten years. As the numbers get bigger, the absolute increments will bring astonishing performance increases in every class of computers.

The consequences of this trend depend on the question of usage. Like many technologies in other industries, the past two years have seen IT technology pass through an inflection point.

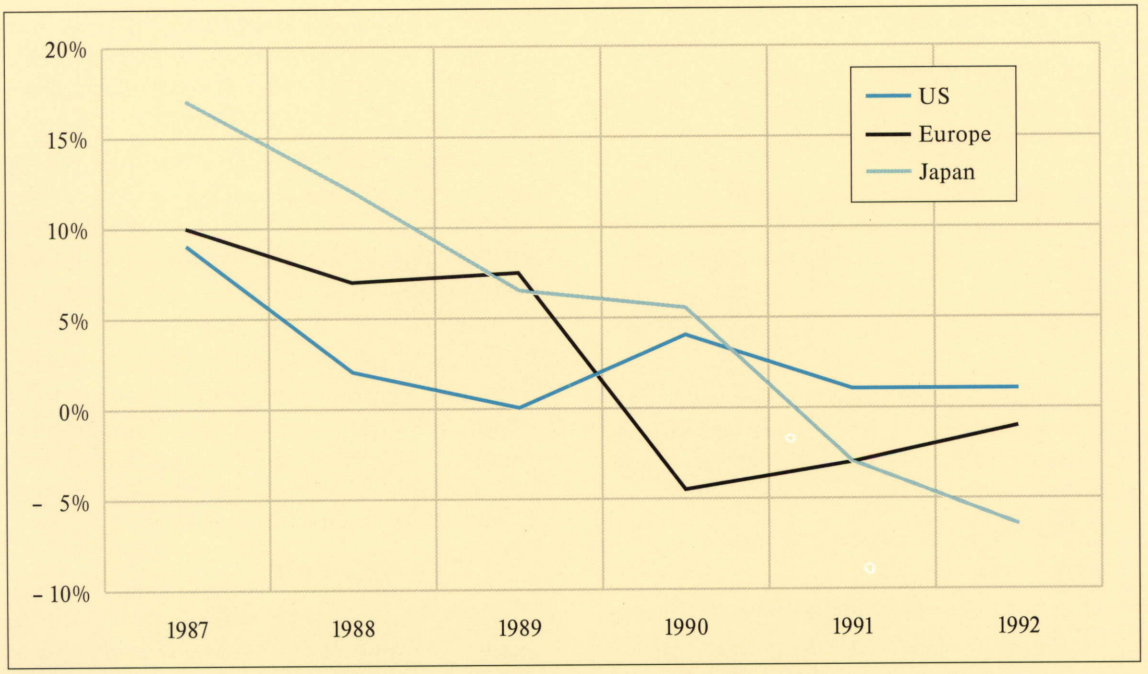


Figure 13
Convergence of Economic and IT Market Growth Rates, 1987-1992

In other words, it passed from being a scarce factor demanding careful use to being a surplus factor that allows use wherever possible. For the user that means it is no longer a question of how to use computer power efficiently, but how to use it most widely because it is so inexpensive.

For IT users and manufacturers this shift brings a new approach to development activities:

The evolution of Windows-based technology has fully exploited this new opportunity. The point of Windows-based software is not to run computer hardware efficiently. It is to make the system easier to use, drawing on as much computer power as possible.

Similarly much greater need for capacity is coming from the spread of distributed computing.

Another driver is the use of agents (sets of programmes that are constantly interacting with networks to meet the needs of the individual customers).

A traditional bottleneck in connecting computers has been the speed and capabilities of networks. Some of those barriers are coming down as network performance increases even faster than computer performance. This is demanding improved efficiency from the terminals.

So, despite being a surplus resource, technology will continue to be a major driving force. This will help manufacturers overcome the problems caused by the spread of standard products and the shortening of product life cycles.

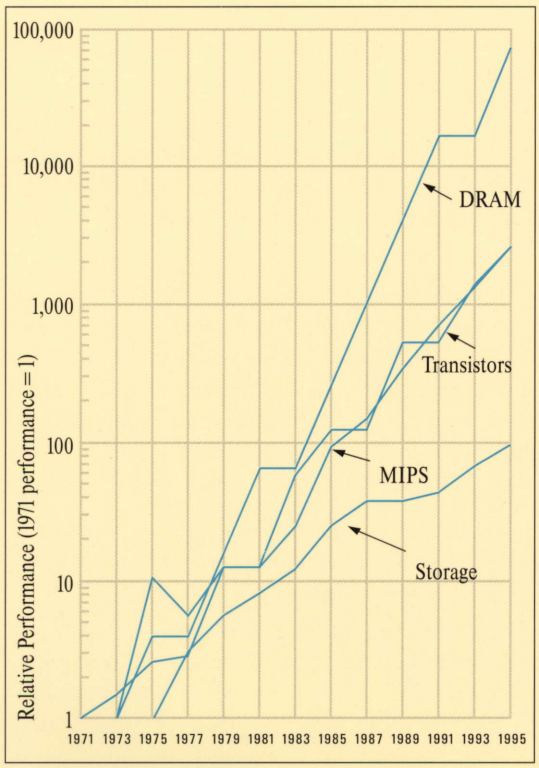


Figure 14
Relative Performance Growth of Four Key Technologies: Transistor Density, DRAM, MIPS, and Magnetic Storage, 1971-1993

New computing model and evolving user needs

The well-worn terminology of today's computing world – downsize, rightsize, resize, mainframes and minicomputers as servers and data repositories – signals the acceptance of a new computing model. This new model features intelligent client/desktop devices connected into a corporate data network, giving the communications infrastructure for critical business applications. Open systems and local area networks are the foundation technologies of this new model, known as client/server.

Deployment of these solutions is speeding up. The drivers are de facto standard operating systems (at system and network level) and a host of accepted standards for local and inter-network communications.

The new computing model is popular both because it is less expensive to install on a limited basis and because companies require the flexibility it provides. With rapidly changing markets and narrowing margins, companies are adopting decentralised organisations consisting of many independent and flexible business units. In this new context the ability to access timely, accurate and complete sources of information becomes even more important.

The new computing model gives organisations the ability to create and distribute information in a more flexible manner than the traditional hierarchical systems. The most advanced organisations see information technology as a key source of competitive edge.

The network is the focal point – the nervous system of the organisation. Its mission is to provide communication infrastructure that allows end-users need to access information wherever it resides and share critical business applications. This means that computer power has shifted towards end-users. More users are joining the information system. Application and processing demands are increasing from new and existing users.

This brings two positive effects to the industry: Systems grow new applications and databases, and increasingly specific demand patterns emerge. These specifications vary by vertical market, application, region and size of operations. Thus they open up niche and local market opportunities. In other words, while technology-push is driving usage development, demand-pull is driving market opportunities.

These applications need integrating. The integration of central and end-user IT resources requires a shift to an integrated vision of the company information infrastructure (as integration involves organisation, applications and finance). The company cannot guarantee such integration with the scarce resources it has available internally. It must turn to external expertise and resources. Again demand-pull creates new opportunities.

The convergence of these groups of factors is destabilising growth of Europe's IT Market. However evidence from trends in other regions worldwide confirms that despite short-term difficulties, Europe's potential is still enormous.

2.1.1. Impact on the Industry: Specialisation, Deconstructing and Reconstructing, Core Business Orientation

The impact of these trends on the industry needs assessing from two points of view:

i. strategic, focused on evolution of the industry's structure at the global level;

ii. tactical, focused on implications for the European situation of behaviours and business models.

Industry structure

As a result, of the above trends, the IT industry has gradually changed structure over the last decade. An industry model featuring virtual vertical integration has overtaken the vertically integrated companies that used to design and build their proprietary hardware, software and communications architectures.

Under this model, players have moved gradually to competing within one segment of the value chain. Separate companies have emerged to lead at each layer of the chain. The layers have remained closely tied to one another because of mutually dependent offerings (thus the model is virtually integrated). Nonetheless these changes have made an essential step in the separation of the product and services businesses.

The quite distinct economics of the hardware, software and services sectors have begun to take hold. This brings specific effects on the supplier structure and business models in each industry segment.

The consequences have emerged very quickly. A key driver of rapid price declines over the last few years has been the end of artificial combinations of hardware and software to inflate each other's prices. Similarly, the unbundling of many labour-intensive services is one of the reasons why that sector has shown such strong growth.

In the medium term, however, as new industries and new technologies emerge, two opposing processes will occur:

- On the one hand, a new phase will start in which the industry will work hard to break its vertically integrated activities into successful self-standing sectors. Each layer of the chain will become increasingly independent from events in other layers. Hardware and software competition will be truly open. The arrival of portable operating systems will facilitate separation in the desktop arena, as this package will be independent from any hardware platform. Increased efforts to unify Unix will do the same in the multi-user/server camp. The scope of changes in this new phase probably won't become fully visible until the late 90s.
- On the other, the telephone and television industries will become part of the information technology base. The result will be integrated hardware, software and service offerings in areas such as multimedia, wireless communications, and consumer IT services. This bundling will bring the customer utility

necessary to jump-start the new sectors. Signs of this early-stage integration come from alliances, mergers and acquisitions taking place among information technology, telecommunications, media and consumer electronic companies. As these new industries mature, however, they will tend to separate into their distinct hardware, software and services components.

Behaviour and business models

Within this changing environment, Europe's IT market is seeing big differences in national demand, despite the potential of IT to straddle cultural and linguistic barriers. User commitment to implement global IT in Europe has two aspects: global as pan-European and as global as worldwide.

The evolution of European IT companies themselves towards globalisation is today at the pan-European level. Their efforts currently focus on reorganising processes and skills into transnational networked organisations, where national strengths grow into pan-European assets.

In this peculiar environment, the IT industry has to consider various choices available for making the most of its market opportunities. This means that IT vendors interested in operating on the European market must

- learn how to deal with uneven and unpredictable European demand;
- learn how to operate in many national markets, segments and niches moving at different speeds (because the Single European Market is still in the process of completion);
- understand that European market dynamics reflect continuous interaction of global technology push and differentiated demand pull.

The ability to understand the specific application needs of the users and the control of the expertise necessary to satisfy them are the key success factors in this jungle of submarkets.

2.1.2. The Impact on the Market

Commoditisation

Technology push, generating a surplus in supply of IT power and features, coupled with break-up of the value chain, have led to the commoditisation of standard IT technology. *Figure 16* in the Statistical Outlook shows how sharply the price per MIPS has fallen for different technology families. The most interesting current trends in commodity technologies involve price-erosion.

While 1992 was the year of hardware price battles, 1993 was the year of software price wars. Until 1992, PC pricing was artificially high for a largely commodity product. This allowed large numbers of low-volume players to succeed. Then market leaders dropped prices to improve share, forcing out second- and third-tier suppliers. Declining prices have demanded larger volume sales for manufacturing efficiencies, marketing overheads, and service. Weaker players have been unable to keep up.

Last year saw software price falls, especially in the PC package market. The causes were user attitudes and market economics. PC price erosion has led users to expect similar cuts for software. Users are no longer willing to buy software at almost the same price as the system.

Software market economics did the rest. Software manufacturers have had difficulties with cost-effective development. To develop all the software it is possible to sell in an increasingly price-elastic market, they have adopted a publisher model. Instead of writing their own packages, they started to market the work of other developers. The strong scale economies in distribution have allowed trade-in policies (new packages offered at the price of an upgrade to win competitors) and suite marketing (word

processing, database, and spreadsheet package offers). These techniques have put very strong downward pressure on pricing, while increasing sales volumes substantially.

New distribution channels

As the industry matures, market share gains become costly necessities. Sophisticated market segmentation techniques and new distribution channels are today important tactics for building share. Attention has turned from the large corporate market – nearly saturated and buying mainly for replacement – to small business and consumer opportunities.

As a result of commoditisation and lack of differentiation, distribution channels have become the most important tools for IT vendors to gain market recognition in both traditional and new target markets. In particular, buying channels used by the new targets are quite different from those of corporate buyers. Within the consumer and small business market, users have a variety of specific needs and expectations.

Consumers' interest and ability to buy computing products vary depending on their income, social status and technology-literacy. The different segments shop through different channels. Computer superstores and direct response are most effective for targeting users who want the hottest technology at lowest prices. Mass merchants and consumer electronic retailers typically appeal to price-sensitive purchasers of basic pre-packaged systems.

Figure 15 gives the breakdown of European personal computer sales by major distribution channels in Europe.

Distributed computing and end-user applications

Distributed computing is taking hold on a global basis: across all countries, across all system types, across all vertical industries. Europe has a distinctive position in this global trend.

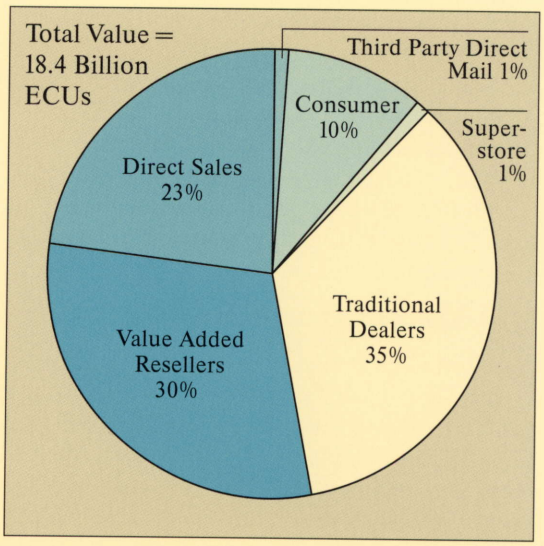


Figure 15
Western European Personal Computer Market.
Value Shipments by Channel, 1993

Users here have a smaller system mentality, with a heavy Unix influence. This creates a strong positive attitude towards distributed computing.

Europe's users are moving to networked distributed architectures either by deploying client/servers or by downsizing corporate multi-user systems. They need a new combination of features for their advanced servers:

- robust application services;
- distributed computing services;
- simple to integrate components;
- ease of operations (installation, maintenance);
- large cache of applications and tools.

Unix has been successful so far as a basic technology for distributed computing. As mid-range multi-user systems matured, they have become a bridge platform into the server world. They offer a rich set of communications and data access software, a strong set of application services, plus distributed services. However, due to the lack of standards, Unix fails to deliver ease of integration and operation.

Figure 16
LAN Penetration and Client/Server Attitudes by Country, 1993

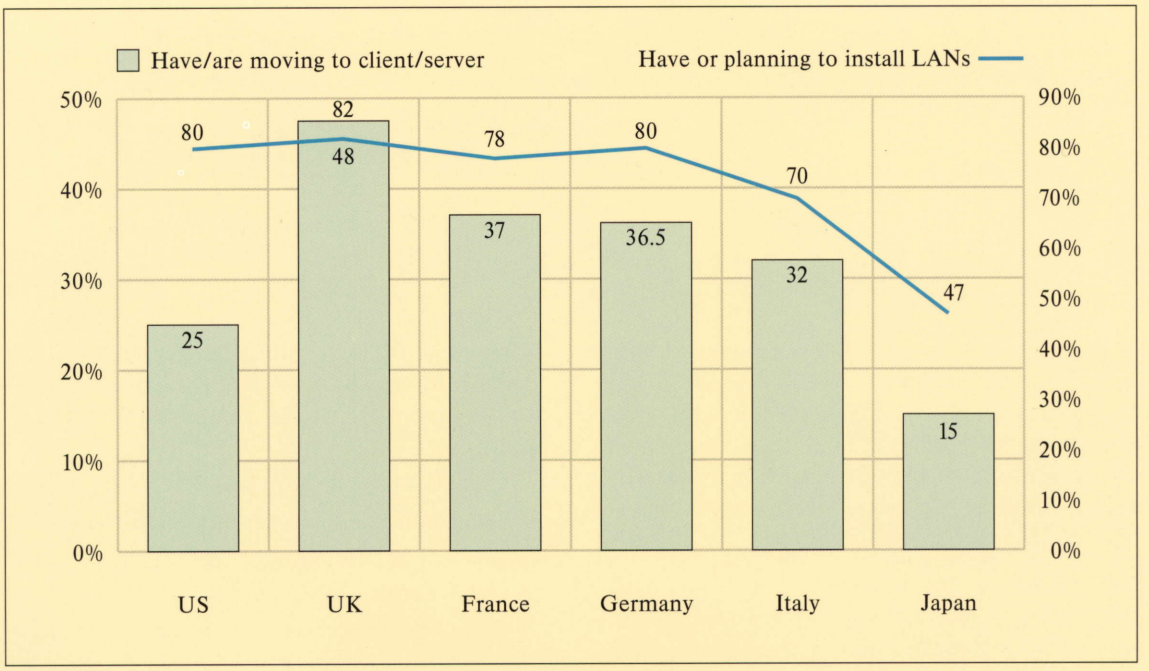
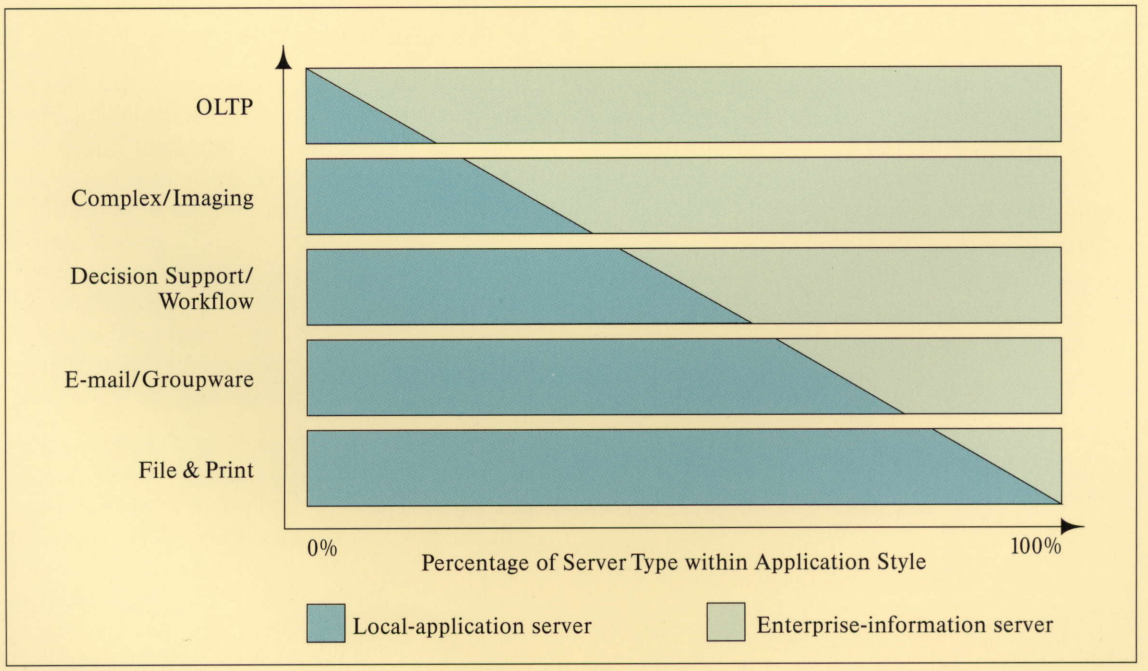


Figure 17
Comparing Server Types and Application Types



	Characteristics	Existing	New/Future
Enterprise-Information Server	Business critical Information capture	Customer records Financials Inventory control Corporate messaging	EDI Resource management Distribution tracking Image processing
Local Application Server	Productivity Decision making	Engineering/CAD Office automation Lead tracking E-mail	Decision support Sales automation Groupware Workflow

Table 13
Application Examples of Enterprise-Information Servers and Local-Application Servers

Fast evolving network operating systems, moving upward from the workgroup and desktop, offer an alternative to Unix. Their plus points are a solid set of simple, LAN-enabled services with easier integration and operation. However, the cost of these features is a lack of robust services and true distributed tools.

Two models are evolving from the race to fill the server gap. One is the enterprise information server. For this niche mainframe/mini architectures and Unix have the stronger positioning. The other is the local application server. Network operating systems enjoy a better position here.

The enterprise information server is the evolution of the corporate multi-user system. It plays two roles: warehouse of corporate information and control station for the flow of corporate data. Primary requirements are:

- MIS affinity;
- enterprise level applications;
- network connectivity, management and integration tools.

Unix is very competitive in these features.

Local application servers deliver and interpret information for specific tasks or operations. They enable users to execute their jobs more efficiently and operate as a cohesive unit. Application servers have two important requirements. They must offer close integration with desktop tools and services. And they must be able to be self-managed, managed remotely by MIS, or both. Key features are:

- variety of application software;
- common set of server and desktop software;
- ease of maintenance;
- LAN connectivity.

Network operating systems are stronger here.

2.1.3. The Impact on the User

Business process reengineering

Users are seeking to improve operations by changing organisation behaviour and business processes. IT is often an important enabler of these changes. As information technology becomes tightly integrated into the organisation's business units, it becomes difficult to separate the business process from the technology itself. In other words, as business processes become more automated, they also become embedded in the information system. It is increasingly difficult to change one without changing the other.

Some four CEOs out of 10 in Europe say they are currently running business process reengineering projects. Of the four, at least three view information technology as a significant source of competitive advantage and a steady contributor to operational capability. From BPR activities they expect better profitability, production cycles, delivery and service quality. Examples of

redesign candidates include: customer support, logistics, distribution channels, billing, order management, personnel, product development.

BPR services embrace the assessment of strategic process objectives, identification of key process, technology transfer appraisal, and change management. Most of the opportunities for the IT industry reside in the second downstream level of services, including: IT planning and design, custom software development, training and education. So BPR can drive market growth not only in management consulting services, but also in PC software training, open-system development tools, LAN/WAN network management.

Outsourcing

The changing business environment is demanding new applications. In particular, the spread of client-servers in decentralised organisations involves the development of applications specific to a user's business.

A key concern of user organisations is their very limited resources for new application development. More than two-thirds of an IS department's spending on headcount typically goes to IT systems operations, management and support. Operations and support costs are relatively fixed and vary little in proportion to the usage of the existing systems. Many of these systems are not strategic, hence non-critical for sustaining competitive advantage.

Moreover technology has evolved towards better price/performance and greater openness. For users, this means many opportunities for beneficial moves to other systems. The chance to overcome old limitations has made outsourcing very attractive.

As a result, outsourcing has gradually grown beyond the traditional idea of "having a third party running the data centre". It has come to mean "any use of an outside contractor to replace or extend in-house resources".

For users this offers a way to turn fixed overhead into variable costs. Also they gain greater flexibility as they overcome resource limits. They can focus on strategic applications. Users avoid the inefficient investment in personnel and technical infrastructure that comes from trying to develop applications for every new area.

Certain activities have therefore become popular for outsourcing:

- maintenance of non-strategic and non-critical systems that employ ageing skill sets;
- one-time projects that require skills the organisation does not have in-house and is unlikely to need again for a long time, such as a major systems migration;
- development of applications for technologies that the firm has not yet invested in and is unsure of the longterm need for;
- new application developments that add flexibility and responsiveness to meet changing user demands.

2.2. The TLC Driving Forces: New Technologies, Standards, New Services, Competition

To accommodate fast-changing demands, today's corporate networks need to be flexible, upgradeable and expandable. For example, the network may be a hybrid. Private point-to-point links handle steady high-volume and high-security traffic. Dial-up bandwidth services cope with traffic peaks and special requirements. Increasingly these networks need to support integrated voice and data communications, plus new applications such as video conferencing. Moreover, the cost of private leased circuits has increased in recent years as a result of tariff rebalancing.

The requirement for integration, and changes in the economics of traditional private networks, pose a challenge for leased networks. They also open opportunities for deployment of new technologies and services.

As a result, the biggest changes currently underway are the move to new technologies and services, and the increased interest in outsourcing. Telecom carriers, IT companies and the host of new operators likely to enter the market after privatisation and liberalisation, will further strengthen the outsourcing trend.

New technologies and services

Technological advances, particularly the shift to digital systems, enable services operators to devise new features for traditional voice services and the new value added network services (VANS). The digitalisation of national telephone networks is enabling carriers to offer new services - such as call-forwarding, call-waiting and caller identification - which until recently were available only in large companies' private branch exchanges.

In the telecoms sector, virtual private networks, frame relay services, ISDN and ATM are the most notable technological advances. They all remove bottlenecks in data transmission and improve efficiency of integrated voice-video-data communication. ISDN and ATM have a particular role in Europe.

The take-up rate of ISDN (Integrated Services Digital Network) has increased significantly over the last two years in Europe, although the EU plan for pan-European implementation of ISDN is behind schedule.

Major obstacles to ISDN's development are being removed:

i. ISDN interface equipment is becoming more widely available, flexible and affordable.
ii. ISDN standards are evolving to ensure better interoperability among equipment and services.
iii. ISDN-related applications are having more impact. Among the ISDN applications becoming popular, are backup of digital leased lines, videoconferencing, LAN-to-LAN communications, file and image transfer, and the recently available PC desktop conferencing products.

ATM (Asynchronous Transfer Mode) technology brings significant savings on transmission costs in both the public network and customer premises environments. The standard overcomes a serious problem in connecting LANs. The unpredictable nature of LAN traffic creates difficulties in choosing bandwidth for wide area transmission. ATM solves this problem by converting LAN packets into fixed length cells, allowing dynamic allocation of bandwidth.

All the major European PTOs are planning to introduce ATM-based networks in mid-90s. Eighteen public operators are preparing the European ATM trial, which will run from summer 1994. The trial's aim is to prepare for harmonised introduction of a European broadband infrastructure. The PTOs are eager to avoid repeating the mistakes of ISDN's introduction, when major operators launched incompatible versions. Multimedia applications - particularly PC-based broadcast video - are likely to be the main driver for desktop ATM technology.

Frame relay is another fast packet switching technology. It too aims to give LANs interconnection that is faster, simpler and cheaper than traditional X.25 packet switched data networks. Frame relay developed first in the UK. It is now spreading across Europe.

Virtual private networks (VPN) give the features and functionality of a traditional private network, without the need for continued capital investment in new technology. VPNs also offer efficient use of capacity on demand. The business customer can link switchboards on different sites without the expense of installing and running its own private network. Sophisticated VPNs offer larger bandwidth for videoconferencing or e-mail traffic peaks. Customers can reconfigure them rapidly to meet changing requirements.

Wireless network technologies are another important area of development. Europe has two standards for digital mobile telephony that are technology competitors with traditional analogue wire networks:

i. GSM (Groupe Special Mobile, now renamed Global System Mobile) targeted at business customers;
ii. PCN (Personal Communications Network), a newer version of GSM, using micro cells.

It may be many years before mobile systems can compete directly on cost with fixed wire networks. Nevertheless, their quality advantages are already clear. Digital technology provides more secure telecommunications. Digital communications are more efficient because by converting ordinary sound into computer code they pack more calls into the same radio spectrum space. They are easier to integrate with modern telecommunications and data-processing equipment, allowing a wide range of value-added services such as messaging, and data transmission.

The adoption of GSM in the mid-1980s as a European standard has enabled infrastructure and handset equipment manufacturers to achieve substantial economies of scale. The first GSM networks launched in Germany, France and Denmark in 1992. Last year GSM subscribers were about one-third of all new cellular subscribers in Europe.

The UK is pioneering PCNs, with the licensing of two competing PCN digital services, one of which launched in 1993.

Two other kinds of networks will facilitate mobile data transmission in Europe: the ERMES paging network and mobile satellite systems. ERMES (European Radio-paging Messaging System) allows for digital alphanumeric messaging combined with electronic or voice mail throughout the EU. Satellites already play a crucial role in mobile and fixed communication. In the US and the UK, they are providing two-way VSAT (very small aperture terminal) telecommunications services to businesses. They also enable communication from remote or inhospitable regions (by journalists or geologists, for example) using briefcase portable satellite terminals.

The planned launch of low earth orbit (LEO) satellites systems will bring the first truly global handheld mobile telephone services. They will offer both global voice and data telecommunications (fax messages, paging, facsimile, computer data services, radio-determination services). The European Commission issued plans in 1990 for developing a single European market in satellite communications. Technology improvements may lead to a fresh look at the international rules for licensing operators of global mobile satellite systems.

Technical advances, particularly the shift to digital systems, enable services operators to promote value added network services (VANS), and to introduce new features:

- Forecasts show use of EDI (electronic data interchange) developing quickly throughout Europe. Currently the UK and Netherlands lead in EDI usage.
- Elecronic Mail services are likely to continue their fast growth.

- Enhanced facsimile services have become very popular. They continue to expand, offering features that enable users to cut and control fax costs (such as fax broadcasting to multiple destinations, automatic retry and deferred delivery).
- Videotext services have also proved very popular, especially in France.

However, outsourcing is the trend that dominates the services area as a whole. Leading telecommunications operators are major players. To get the scale economies needed to build and integrate global networks, they have grouped together or allied with large companies. Target customers are multinational corporations and other large organisations who want someone to manage their internal networks and facilities or to buy-in sophisticated network services.

The range of services provided by outsourcers is growing. It typically includes managed data network services, electronic data interchange facilities, short-dialling options and electronic mail. Software tools in development will allow virtual private networks to internetwork and to support a common set of features.

Competition

Around 20 privatisations of European national public telecommunications operators (PTOs) are due in the next three to four years.

Total market capitalisation of the newly privatised companies is likely to be around 116 billion ECUs. Worldwide, some 46 telecommunications companies have separate listings. By the end of the decade that number could have doubled. In Europe alone, telecommunications companies could be a larger equity sector than banks by the end of the decade.

This poses unprecedented challenges and opportunities for the sector. Already serious international competition between alliances of telecommunications companies has arrived.

Competition and privatisation are proceeding hand-in-hand. In June 1993 the EU agreed a timetable for competition between operators in national voice traffic. All the EU's larger countries have agreed to allow new operators to compete with their PTOs by January 1998 - except Spain and Germany which can maintain monopoly for a few extra years.

By 1998, it is also likely that most of Western Europe's leading PTOs will be wholly or partially in the private sector. The UK government sold its remaining stake in British Telecom in summer 1993. Germany, Denmark and the Netherlands are planning partial privatisations: Germany by 1996, the other two by the end of 1994. Part or all of the PTOs in Italy, Spain and Portugal already have public listings. A reduction in the government-owned stake is probable in all three. The French Government is likely to put its national PTO on the next list of public companies for privatisation. Several of Europe's smaller states are thinking of privatising their PTOs, although after a period of corporate status. By the mid-90s only Austria, Norway, Luxembourg and Switzerland are likely still to have old-style state-run PTOs.

Each privatisation is different. Solutions vary case-by-case for issues such as valuation, regulation, reserve government powers and guarantees of employees rights. However, two common models are emerging:

i. Smaller PTOs favour selling a stake of about one-third to an established international operator. In return, they want management expertise, plus investment and marketing resources. They can then float a smaller stake on the domestic stock exchange, leaving the state with 51%.
ii. For larger PTOs, a conventional flotation is the most common course. This does not prevent alliances with other international operators.

Liberalisation will boost market growth, and there are no fears of market saturation. In every European country, growth in access lines, calling volumes or network use has consistently outperformed the economy's growth and the world market sector averages.

The main reason why deregulation is helping growth is that many favourable and interrelated conditions are developing at the same time: for example, the shift towards services, increased globalisation, new technology, declining costs and prices.

Key industry characteristics include large up-front investments with very low marginal costs of production. The operating leverage is therefore very attractive. For example, the circuit capacity of undersea fibre-optic cable systems has multiplied twelve times in seven years. While in real terms the price has remained constant, and the cost per circuit has reduced by nine times.

The problem is not to create sufficient telecoms capacity, but to find practical and affordable uses for the huge volume becoming available. That is why deregulation will help growth. Privatisation and liberalisation will introduce a host of new operators, small and large. Competition between them will push the industry into still faster growth.

2.3. The Emergence of New Markets: the Merging of Computer, Consumer Electronics, Media and Telecommunication Industries

The most far-reaching opportunity emerging in the ICT industry is the development of a new breed of market.

Computers, telecommunications, consumer electronics products and media are converging into a single new medium: the electronic highway. This convergence promises to create a revolution as profound as the Industrial Revolution of the last century.

Building the new digital media infrastructure involves not only a range of industries. It also demands both expanding the functions of existing products and building completely new products. Different trends in each industry are coinciding to drive the new concept:

i. Information technology industry: Computer companies have strong positions for winning a large number of home-customers, due to:

- development of wireless computer technology;
- commoditisation of PC products;
- enhancements in networking hardware and software technologies;
- their hardware/software expertise, their solution integration and their standard-setting expertise will be valuable to IT makers in these new markets. Through joint ventures and alliances they have started to develop new hardware platforms and new languages for creating communication-oriented applications.

ii. Communications industry: Many factors are giving telecommunications and cellular carriers a major role in the convergence trend:

- infrastructure;
- switching and digital compression enhancements;
- financial strength to continue investments;
- cellular technology brand awareness;
- continued price declines caused by increasing competition;
- adoption of international standards.

iii. Media and entertainment industries: Globalisation in the media and cable industries is encouraging growth of entertainment empires and global news networks. They combine such assets as huge film-libraries, cable TV channels and control of access to huge numbers of domestic TV viewers. Many strengths built up through managing their core business will help these companies in the convergence era:

- experience in broadband technology;
- information assets;
- information gathering infrastructure;
- information packaging expertise and advertiser relationships.

iv. Consumer electronics: The lines are blurring between pocket organisers or portable multimedia players and personal computers. These new developments are helping consumer electronics makers address new markets such as integrated home/office information. Their key strengths in the new market include:

- time-to-market capabilities;
- low-cost manufacturing;
- brand awareness.

Computer makers and consumer electronics companies were the hot favourites for technology alliances and acquisitions in 1992. The purpose of these alliances was to pool expertise and create new products able to merge the video, voice, and compact features of TVs and pocket organisers, with the interactive capabilities of computers. This cooperation has given birth to a new type of multimedia product, the personal digital assistant, first launched in mid-1993. IT companies have also started partnering with publishers and information service suppliers to build critical mass for their new architectures.

The launch of this new kind of product, combined with increasing availability of data network services able to handle all forms and almost all quantities of multimedia data, has considerably increased growth potential for the on-line interactive information business. This explains the involvement of the providers of telecommunication infrastructure, making communication possible, and the media industry, supplying huge quantities of information.

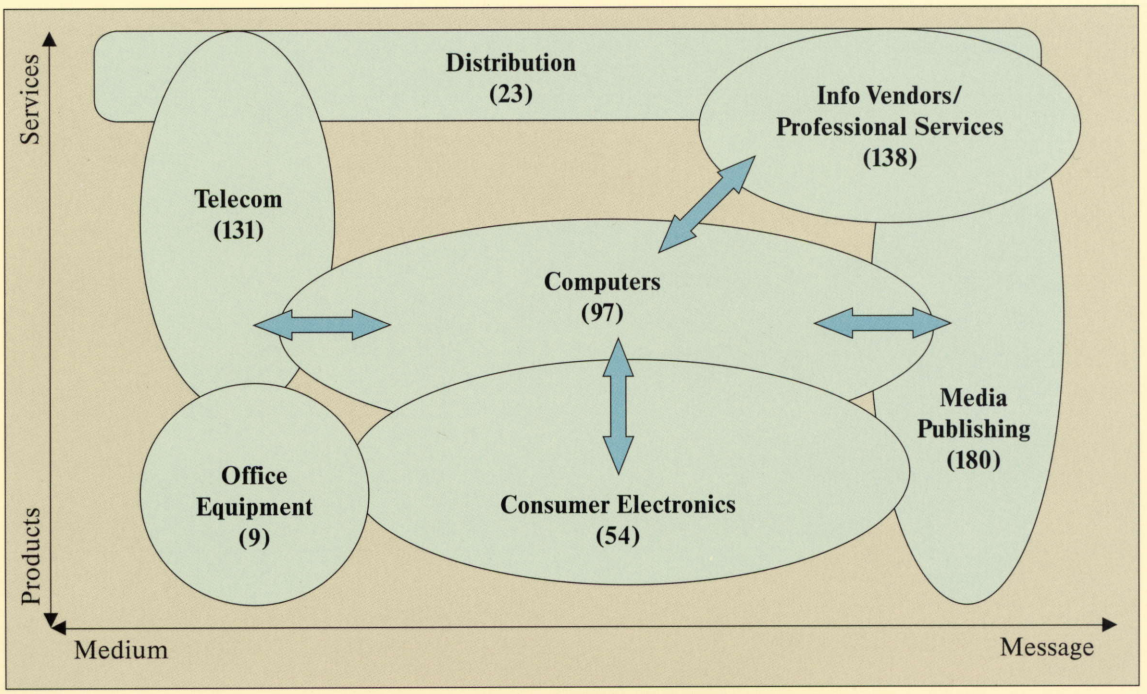
Not surprisingly, 1993 was the year of mergers, acquisitions and alliances between telecommunication carriers, cable-TV operations, broadcasting stations, film and music publishers, and computer companies.

Telecom operators can offer their technology – wired, cellular or satellite – and their expertise in switching information. They need, however, the cable companies' higher data capacity. The broadband pipes of cable firms carry pictures, voice and data into the TV subscriber's home, and complement the telephone companies' old wiring infrastructure for domestic voice traffic. The purpose is to develop a new tool: the interactive television, which lets viewers order movies, shop from televised catalogues, play games with other subscribers, or do research for school reports.

Entertainment media companies are combining their huge film and record libraries with cable distribution networks. Telecom operators are adding their transmission technologies and their expertise in switching information. Computer companies see interactive television services as a major opportunity to create new markets.

- They are especially keen to enter the high-volume consumer market where they see a second life for technologies developed for business users.
- They are signing agreements to provide media companies with technologies for cable TVs (printers, wiring, chips, other IT components).
- They are developing new interactive entertainment systems running software on compact disc.

Figure 18
The European Information Business Area, 1992 (Billion ECUs)



Source: EITO, Eurostat

Number in brackets are referred to market value in Europe.

- They are testing mainframes or smaller computers as servers storing data and videos and managing traffic in interactive networks.

The USA saw 1993's deal of the deals in this arena, on the back of the government plan for digital communications superhighways. It was the acquisition of a cable giant by one of America's largest telephone carriers. The carrier controls 18 million phone lines and 850,000 cellular phone subscribers. It is one of the biggest US network software and services providers. The cable company's lines add another 10 million customers. The dream behind the acquisition is to bring interactive multimedia services to the mass-market.

These events are a clear indication that technology will realign all the businesses that carry capabilities needed to capitalise on one of the decade's best growth opportunities. The magnitude of this growth is clear from the differences that still exist in European households between penetration of personal computers and colour televisions or telephones. However, for the opportunity to blossom, international standards and open technologies have to prevail in the networks. The ability to move across the highways will determine success.

The major challenge for public policy makers and regulators is to encourage this new market to develop as quickly as possible, because being in the forefront of this movement enhances the opportunities. Convergence taking place at a huge rate in any country or region, enhances that country or region's global opportunity.

Country	Home PCs	Cable TV	VCRs	Telephone	Color TV
Europe	20.8	20.5	46.4	83.8	92.6
Germany	28.0	31.0	43.0	74.1	96.0
France	16.0	3.0	47.9	95.0	92.9
UK	24.0	2.0	65.0	89.0	93.0
Italy	20.4	N/A	24.0	88.4	84.0
Spain	11.5	1.0	43.9	75.0	94.1
Austria	9.0	28.0	48.0	87.0	94.6
Belgium/Luxembourg	22.0	92.0	48.0	97.0	95.0
Denmark	7.3	34.0	45.0	96.6	96.0
Finland	24.0	27.0	50.0	93.0	90.0
Greece	5.2	N/A	12.0	84.6	78.0
Ireland	18.0	39.0	54.0	61.0	93.0
Netherlands	20.0	84.1	55.0	98.6	96.0
Norway	17.0	40.0	57.0	93.0	97.0
Portugal	9.0	N/A	41.0	61.0	83.0
Sweden	14.0	43.0	70.0	96.0	93.0
Switzerland	18.6	60.0	45.0	98.0	92.0
US	31.0	59.0	76.0	92.4	98.0

Table 14
Household Penetration of Major Electronic Media (% of Households), 1991

Source: OECD, various according to country

3. IT and TLC European Market Perspectives

New technologies, new markets and new usage patterns are about to stimulate a new era of expansion in the ICT industry. Drawing from the major findings of the preceding analysis, the following points highlight major drivers for and possible obstacles to this expansion.

3.1. Growth Factors (Economic, Technical, Political)

3.1.1. Economy

Growth by innovation

Recent years have seen a growing link between the economy and the IT business. This has developed from many factors: recession froze IT user investments, the business is bigger and growing more slowly, the sectors involved (PCs and services) are much more fragmented and there is more discrete and variable expense in contrast to capital intensive mainframes.

However the most important factor is that more and more economic growth is coming from new initiatives in which IT takes a major role.

The higher the investments in private and public high-tech initiatives (integrated airlines, communications, banking systems), the greater the positive effect on ICT market growth. The European integration process will be the core driving force of this economic push.

New competitive environments

Pressures from the competitive environment are bringing changed user attitudes to IT and communications, plus fast growing new markets for the industry. Companies are adopting decentralised organisations consisting of many independent and flexible business units to cope with rapidly changing markets, global competition and narrowing margins.

Users are seeking higher efficiency through reengineering of business processes. As business processes become increasingly embedded in information technology, this often means reengineering the entire information system.

The need for higher returns from the information technology and communications infrastructure often leads user organisations to consider outsourcing facilities or functions to IT services companies or network specialists.

The European peculiarity

Although the European IT industry is going through a painful period of transition, it can count on a market that - due to history, national economy, political factors and culture differences - is still far from saturation. Paradoxically Europe is also far from being a single market. In reality it comprises a number of different submarkets, in which different mixes of products and services sell under different conditions, to differently behaving users, through a variety of distribution channels.

Some of these markets are enjoying good growth, many others are declining. Both local peculiarities and the attempt to overcome them to create a more harmonised integrated market currently make this highly variegated composition generate a number of niche or innovative areas of great potential. But there is also a negative side to this situation, discussed below.

3.1.2. Technology

Technology surplus

Progress of primary technologies will continue to be dramatic, as technology passes from being a scarce factor needing efficient use to being a factor in surplus, available for use wherever possible.

Traditional bottlenecks in performance of networks are disappearing. New types of applications are arising to address the automation of old and new processes. The emergence of new technologies as de facto standards attract broad support from the industry and result in booming markets. Therefore, technology push will continue to be a major driving force.

With rapidly changing markets and narrowing margins, companies are adopting decentralised organisations consisting of many independent and flexible business units. In this new context the need to access timely, accurate and complete sources of information becomes even more important.

New computing architectures

Open systems and local area networks are driving the spread of the new client/server computing model, based on intelligent client/desktop devices connected to the enterprise network

infrastructure. This model makes communication flow more efficient throughout the flexible decentralised organisation, by shifting more computer power to end-users.

As a result demand-pull creates new growth opportunities for the industry, of two types:

i. The number of new applications and databases required increases because of both the number of users added to the network, and their different demand patterns.
ii. The integration of central and end-user IT resources often requires new expertise and resources external to the company: traditional internal IT expenditure is shifting outside.

Digital media highways

Technology is drastically realigning the computer, communications, media and consumer electronics businesses. The convergence is giving birth to a new medium: digital media highways.

New market opportunities are coming from potential new services and technologies for the business market, which can effectively address with attractively priced applications the huge consumer market. Penetration in non-business environments will enable the computer and new communication service industries to reach the same business size as other mature products and services, such as telephones, television or automobiles. Without doubt this is one of the highest growth opportunities for the industry.

3.1.3. ICT Public Policy

Public policy for the ICT industry will increase growth as long as the following major lines of action are pursued. They are already underway in varying degrees at the national and European levels.

Competition

Governments benefit from creating an industry environment that is truly competitive, since the most successful current operators and regions in both the IT and communications industries have achieved their positioning by operating and developing in highly competitive domestic markets. Ensuring the same conditions of access to markets, and the same costs of the inputs, is fundamental for maintaining European ICT industry competitiveness and growth. On the demand side, competition makes markets more price efficient, and declining price-points generate more demand.

Demand

Governments generate a significant portion of demand as buyers of ICT technology and services. In the IT market alone, public procurement accounts for approximately one-fifth of European expenditure. The public sector can give a further push to ICT market growth through the outsourcing of IT and network services, investing in new applications and financing large infrastructure projects focused on digital communication highways. The key to generating growth is taking a leadership position as a buyer and implementer of the most advanced products and services.

Standards

Another major objective of ICT public procurement is to identify important new technologies and act as the symbolic champion of their standardisation. That involves both investing in their implementation and attracting attention to them. As the computer and communication industries have demonstrated in the past, standards are highly valuable to create or accelerate growth. Also, the development of the new digital highways strongly depends on standards and open technology.

Supply

The chief assets of Europe's IT industry are its IT and network services sectors. They enjoy two advantages over international competitors:

i. technological and cultural proximity to European clients;

ii. the contribution they can make towards development of a new European technological infrastructure by leading large-scale integrated projects.

Their major limitations are their lack of international scope, business size, and access to professional skills.

Governments can play a fundamental role in strengthening the European industry by investing in training and education, by continuing to promote corporate cooperation in R&D and by exploring new possibilities for applications of new technology.

New markets

This is the major challenge for public policy makers and regulators. The efforts of the US public administration in launching the plan for digital communication superhighways are a clear example. The objective is to promote the fastest development for these new markets, by promoting competition, ensuring coherent tariffing and investing in the digital infrastructure. Being a protagonist in the forefront of this movement only enhances the opportunities. Rapid convergence of these industry sectors in any country or region can only enhance that country or region's global opportunity.

The convergence trend is affecting growth of the European IT market, and the immediate future may see some problems. However evidence from elsewhere in the world confirms that Europe's potential is still enormous.

3.2. Critical Factors and Impediments to Growth

The major obstacles to ICT industry growth might well arise from the conflicting cultures and goals of the companies which are now finding themselves in the same industry.

Multi-industry alliances

Today the nature of coalition building and introduction of new technologies is becoming more complex. The integration of components to deliver new functions requires larger alliances, bringing together increasingly diverse companies, with different philosophies. Such big alliances may prove unworkable when discussion starts on products or priority of goals. For example, information content is a high-value asset for media companies, while computer makers place little value on it. Copyright protection and transaction security are two major sources of possible conflict.

New technologies

New platforms need hot technology and performance, which even very aggressive upgrades and modernisation might not supply. In digital media, new performance and functions mean some combination of new information, or new ways of partitioning information, or new ways of transporting and personalising it. Lack of sufficient functional improvements to attract widespread purchase might well delay or kill growth opportunities.

Price points

The latest technology very rarely gets bought for technology's sake. Even if the technology is powerful, consumers need more than just performance. Their purchase decision involves assessment of improved function plus an attractive price point. The price points of multimedia systems, for example, are still above the expectations of users, although likely to decline soon.

Interoperability

Next generation communicators/computers will need broad interoperability to become mass-market products. For example, their software should run on every manufacturer's device, as do CDs and cassette tapes. However, the current market for multimedia PCs remains highly segmented, and several potential multimedia platforms lack the most basic software interoperability.

European peculiarity

The demand pull that will drive growth of distributed computing and digital communication services will develop as user organisations become decentralised and transnational. For this reason, we have talked about Europe's peculiarity of being many markets in one as an advantage, multiplying niche markets and demand for highly sophisticated integration services. But there is a negative side, too. When corporate users want to implement pan-European networks and systems, Europe's national differences often produce conflicts rather than synergies. Cultural and infrastructural obstacles are equally significant. User organisations see as the greatest barriers differences in software (infrastructural, rather than packaged applications), work practices and language. National prejudices are also a major obstacle for cross-border computer and network systems.

Lack of skills

European market differences also amplify difficulties in the availability of skilled ICT personnel. Language obstacles with personnel, the amount of training needed to manage pan-European corporate nervous systems, and differences in skills and academic preparation, amplify the structural European problem of a general lack of skills in most countries.

The current recession is providing temporary relief of the skill shortage problem. However cultural barriers and the declining youth population will become major obstacles in the short-term if standardised IT training is not available throughout Europe.

3.3. Medium to Long-term Scenario

The success of the European ICT industry in the medium/long-term scenario depends strongly on two major opportunities: infrastructure and people. In this scenario the likely positive effects of global factors on ICT growth are already clear.

On the supply side:

ICT Technology will continue its steady growth in power and performance delivery.
A new medium - the digital highway - and the interactive tools to access it are becoming available as a result of convergence and partnering of the ICT, media and consumer electronics businesses.

On the demand side:

Economic globalisation will make information the organisation's key strategic resource, making the role of ICT even more important.
Growing familiarity of business and domestic users with digital technology will overcome the psychological barriers to massive use of interactive devices.
Declining prices of cellular network services and digital technology will favour their uptake by new user segments.

European success as well depends very much on these trends. However the probability, under this global scenario, that Europe will enter a new phase of longterm development hangs very much on the twofold nature of European market fragmentation. The crucial factors will be infrastructure and people.

Infrastructure: market building measures

The promotion and roll-out of digital highways are only first steps towards realising the new infrastructure. Technology alone is not enough to spur growth if the market is not there.

Creating the new infrastructure requires closing ICT penetration gaps across Europe and with other regions. This requires promoting new public and private services in the business and consumer environments, and exploiting the potential demand generated by national differences.

The new infrastructure will result from two factors:

i. EU and ICT industry commitment to establishing operating networks and institutional community systems;
ii. development of large-scale integrated projects to make the new infrastructure worth using by business, public and private users. This commitment has to be continuous and pan-European.

To ensure exploitation of the new growth opportunities, both the EU and the European IT companies need to work together. They must ensure that the medium-term scenario will be one of coordinated harmonisation. In particular, industrial strategy needs to focus on new opportunities, alliances and systems integration.

People: the critical resource

The history of Europe's people has developed, for better and worse, from their diversity of cultures. Progress and market success have always come when the local skills and financial strengths of one region have successfully answered market and financial needs in other regions.

A similar challenge faces the ICT industry at present. The scarce resource is no longer technology, but the people needed to implement it at pan-European level. Technology push and multisector convergence are generating more demand for skilled ICT people.

ICT specialists need the ability to

- work with different cultures and nationalities;
- understand business processes bundled into ICT technology;
- perform new strategic roles in the organisation that do not exist today (for example, the communications manager as a complementary professional to the MIS manager).

At a time when the ICT industry in Europe is losing jobs on the manufacturing side, bigger opportunities are opening for new, highly qualified professions. Unlike manufacturing jobs, these occupations will not be at risk of export to low wage regions.

IT highways: big market potential

The pervasive opportunity of digital highways and European ICT market potential is still enormous, and it is close to becoming a source of actual market growth.

The convergence of technologies towards interactive business and consumer applications, and the co-ordinated harmonisation of the European ICT environment, will play a big role in ensuring full exploitation of this enormous potential.

Information Technology: The State of the Art and the Key Technological Factors of Evolution

1. Evolution in ICT: A Global View

As in the EITO '93 report [see Ref.: EITO 93], the aim of this chapter is to outline the most important technological factors in Information and Communication Technology (ICT) which are of decisive importance for the market now and which will continue to be so in the near future. The approach followed is the same as that in the past report. The basic technologies that underline the evolution of ICT are:

- microelectronic component technology;
- hardware computer technology;
- software technology;
- telecomunications technology.

These technologies cooperate and interoperate by means of *architectures*. The evolution of technical architectures plays a key role in ICT and both influences and is influenced by the above-mentioned evolving technologies.

Viewed as a whole, ICT also influences and is deeply influenced by a market which this EITO report has subdivided into office products, EDP systems and telecommunications. All these relationships are shown in *Figure 1.*

The EITO '93 report presented a general view of technological trends. All those trends are still valid, and therefore, in the present report, only certain specific items have been considered, so as not to repeat the technical exploration already done. For this, the reader may refer to the contents of the previous report.

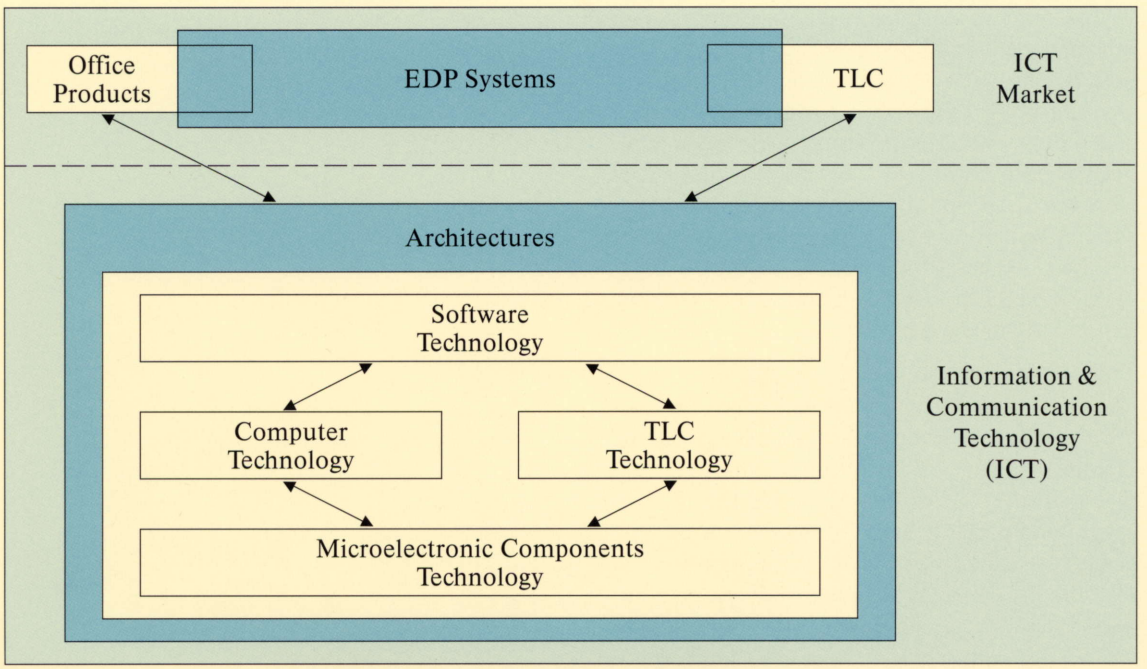
The megatrends for each technology are synthesised in *Figure 2*. They are exactly the same as those discussed last year.

Spectacular improvements in microelectronic process technologies, device physics and computer architectures have led to continuous improvements in the capacity of computers to process, store and present data. In many ways, this progress has been mirrored by the rapid development of the IT industry as a whole.

The exciting pace at which the microprocessor developments have taken place owes everything to the advancing capacity of silicon planar technology to increase the number of circuits per chip, the number of chips per wafer, and the number of functions per chip, by effecting order-of-magnitude reductions in device dimensions. *Figure 3* shows the relative performance growth of storage, MIPS, transistor and DRAM. *Figure 4* shows the storage capacity explosion. *Figures 5, 6 and 7* illustrate respectively the growths of the chip density and MIPS for a family of processors, and of DRAM chip capacity.

To pinpoint the evolution of the microprocessor as the prime driving force behind the development of the IT industry is to over-simplify the case. Parallel developments in operating systems software, memory devices, secondary storage technologies and network-related technologies all contribute to the increasing capability of computers. In fact, the subject deserves to be extended beyond issues of the underlying technological infrastructure into areas intimately related to the direct application of technology to the solution of business-oriented problems.

Figure 1



Source: EITO

Figure 2
Technical Megatrends

Microelectronics	Hardware Computer	TLC	Software
- VLSI → ULSI - DSP - Advances in packaging - 64 bit microprocessor - Constantly decreasing component prices - Flash memory	- System downsizing and upsizing of the system complexity and capabilities - Increasing systems reliability and availability - Parallel processing - TLC and multi-media integration	- Full digital approach - ISDN - High speed high capacity networks - Services integration - New services (Audiotex, interactive TV) - Mobile personal communication and computing - LAN equipments	- High level development systems and languages - Improvement of the human interface - Able to manage multimedia information - Objectware - Middleware - Fuzzy logic

Source: EITO

Improvements in computer technology over the years have not been confined to the field of microelectronics alone. For example, operating systems have followed a similar evolutionary path. Early batch-processing techniques have been augmented by the techniques introduced with the subsequent multiprogramming, time-sharing, and multiprocessing operating systems. A further successful dimension of the development of the IT industry is the rise of networking, particularly of the LAN.

Against the background of such a spectacular rate of development, it is easy to believe that there is no limit to the rate of improvements the IT industry can provide through improved microelectronics technology. However, this is an arrogant and possibly dangerous assumption. The bases for many of the improvements observed over the last 30 years have been advances in our understanding of semiconductor physics and processing technologies. This understanding has been used to reduce continuously the width of the smallest individual elements and circuits that can be laid in silicon. In order to continue developing at the same high rate, it will become increasingly necessary to solve a different class of problems, many of which are only just receiving serious attention.

It is possibly and likely that the future development of the IT industry will owe proportionally less to advances in microelectronics and more to other disciplines and dimensions of development. Distributed computing, parallel computing and new methods of producing complicated software applications are potentially fertile areas of opportunity.

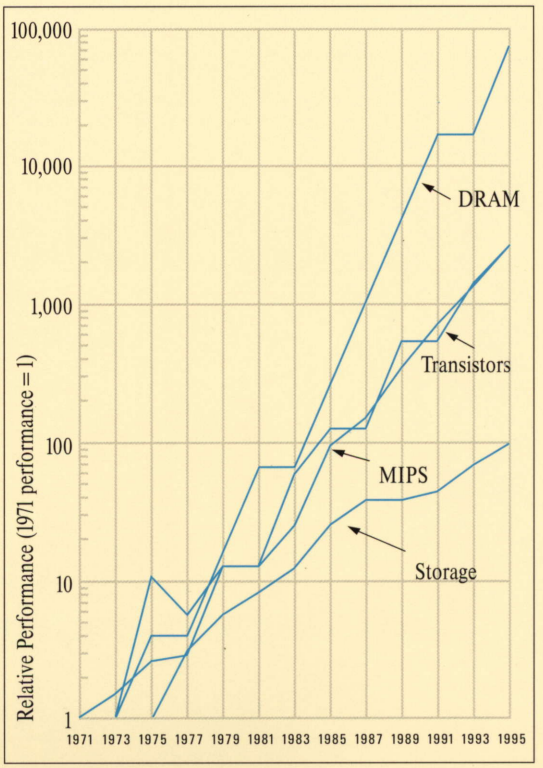


Figure 3
Relative Performance Growth of Four Key Technologies: Transistor Density, DRAM, MIPS, and Magnetic Storage, 1971-1993

International standardisation continues to play a key role for ICT as a whole and, in comparison with the situation described last year, two main events can be considered key "news":

- the technological trends considered have been realised, and the related "new" products, systems and services have been launched and are spreading on the market;
- the merging of computers, consumer electronics, media and telecommunications, which produces a "new" information arena (see *Figure 8).*

Figure 4
Storage Explosion: Worldwide Captive and Noncaptive MB Shipped, 1987-1996 (est.)

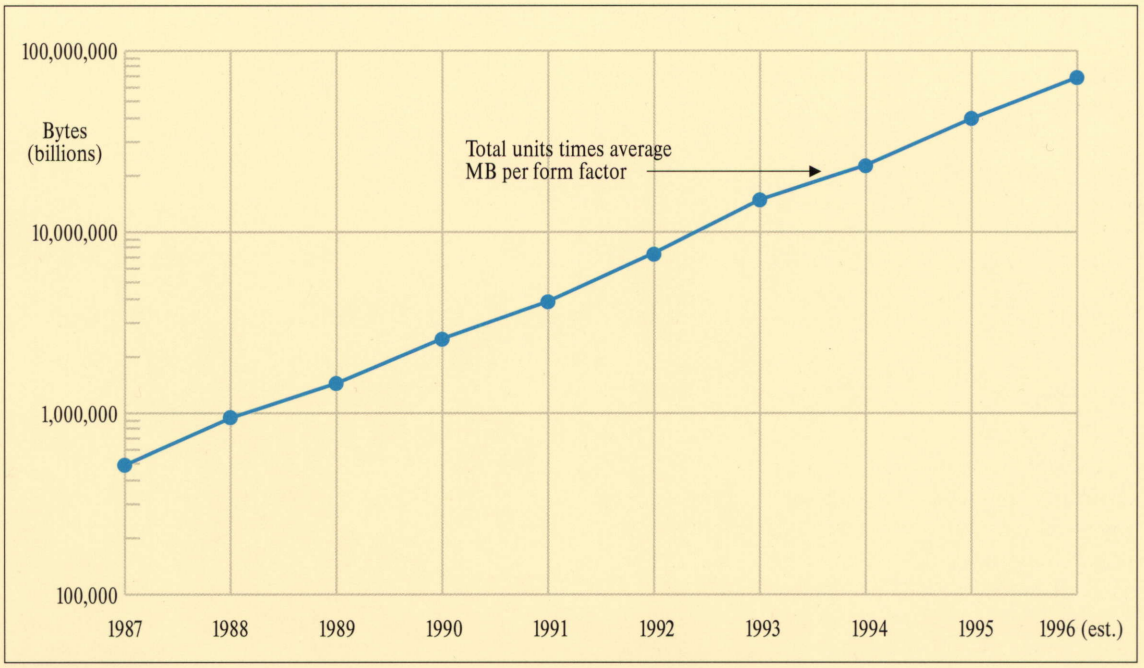
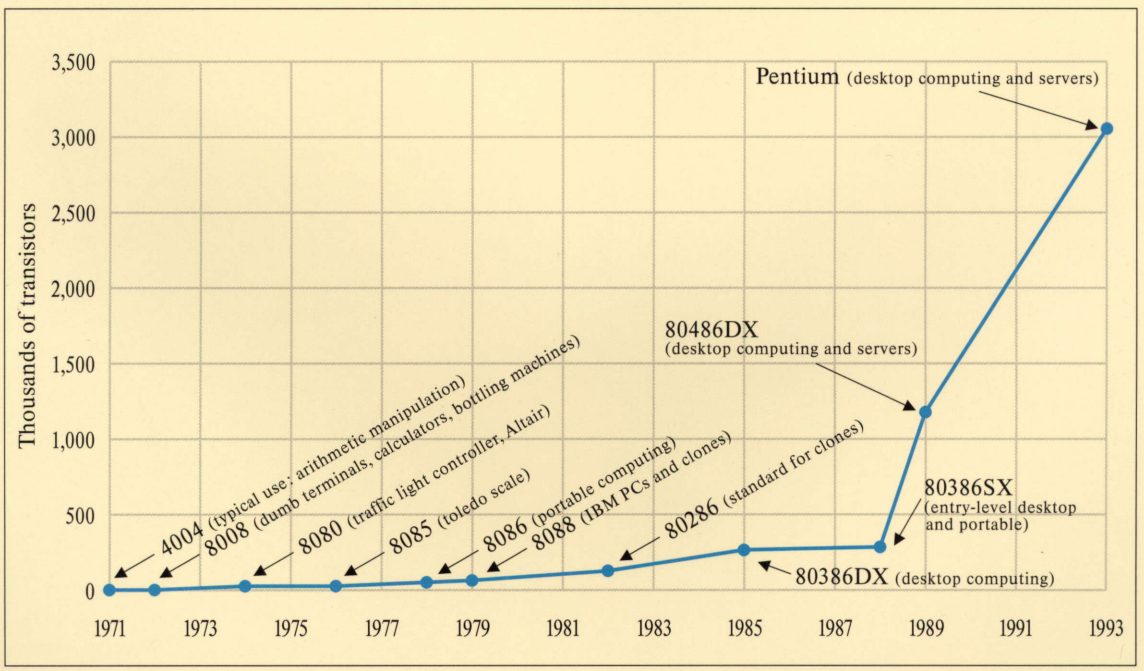


Figure 5
Transistor Chip Density in Intel Microprocessors, 1971-1993



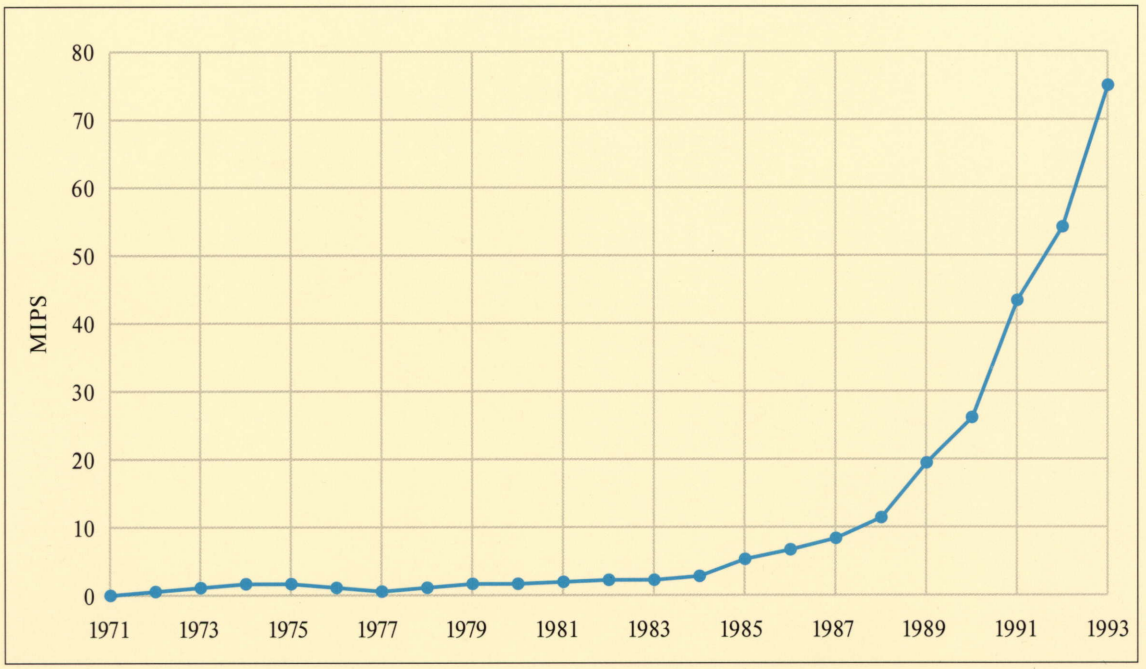


Figure 6
MIPS Growth in Intel Processors, 1971-1993

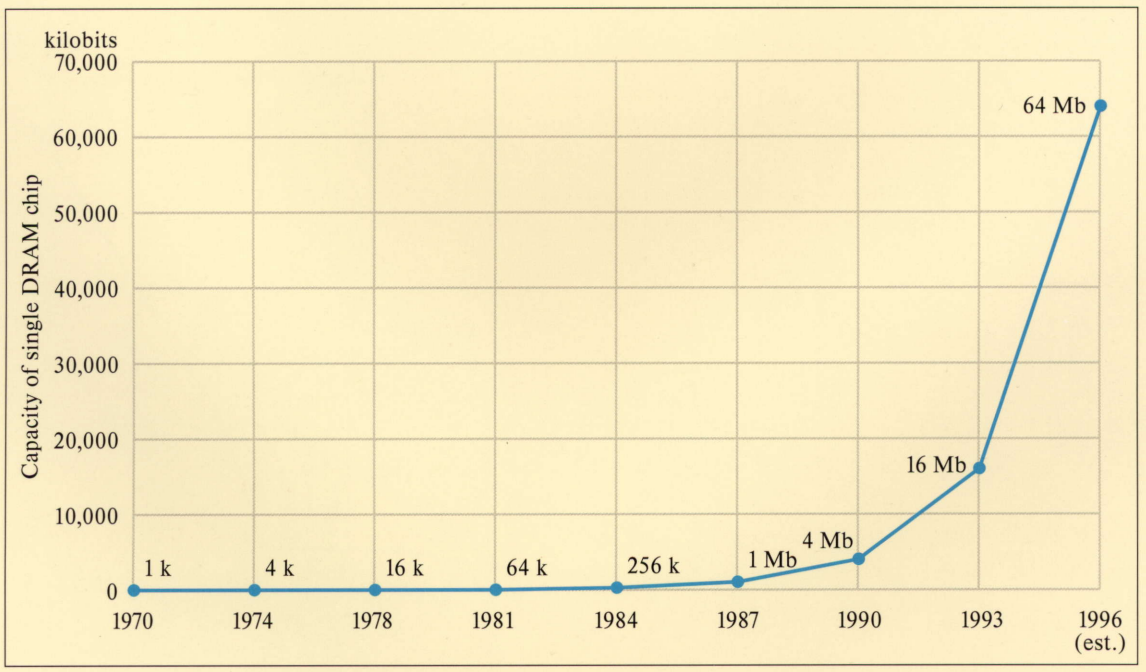
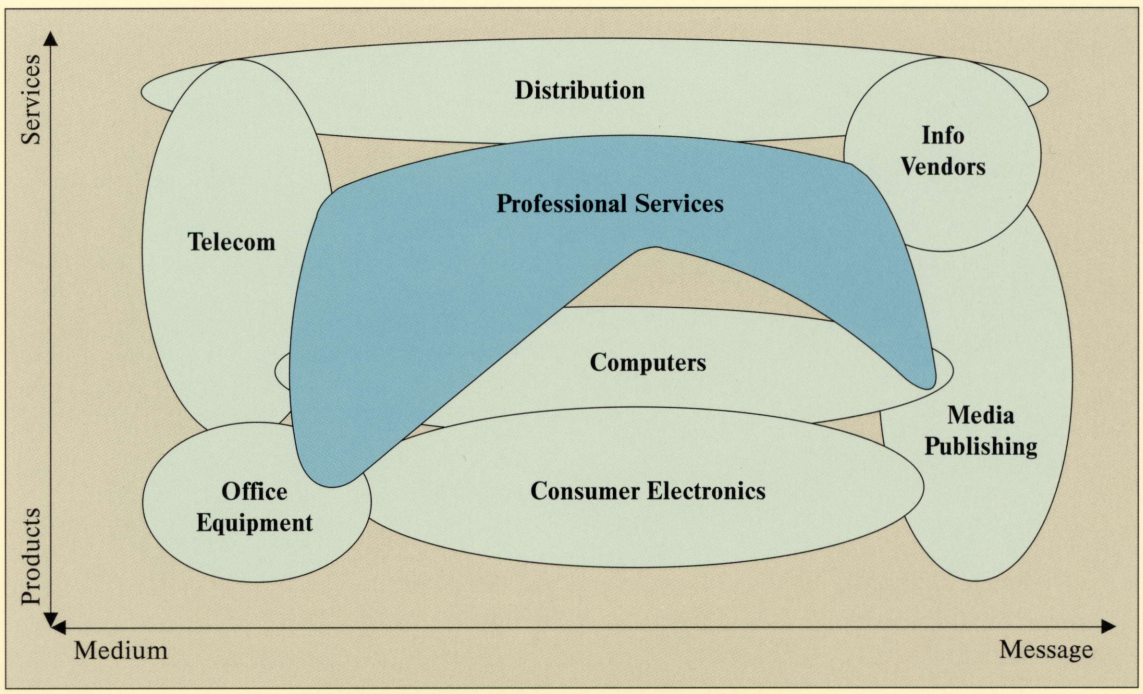


Figure 7
DRAM Chip Capacity 1970-1996 (est.)

Figure 8
The Information Business Area



Source: Harvard University

2. Microelectronic Components

The key issue is the continuous improvement of the integration level, from VLSI, Very Large System Integration to ULSI, Ultra Large System Integration, which allows the creation of 64-bit microprocessors. This evolution has a parallel evolution in component design and manufacturing.

The current trends in microelectronics can be condensed into the following main activities (for more details refer to [DGIII-1 and 2]):

- an ever higher level of integration of functions > three million transistors per chip (VLSI → ULSI);
- the use of mixed signal techologies (analog/digital);
- bipolar and CMOS technologies on one chip (BiCMOS);
- 3.3-V circuitry to accommodate notebooks and other portable equipment;
- flash EEPROM's replacing EPROMs and EEPROMs;
- advances in packaging (MCMs);
- the "invasion" of 32-bit microprocessors *(Figure 9)*;
- 64-bit microprocessor architectures (Alpha, Power PC, i860);
- I-Line optical lithography, phase shift masks;
- separation into foundries and fabless IC houses;
- standardisation of high-level design languages;
- conversion of fab lines to eight-inch wafers.

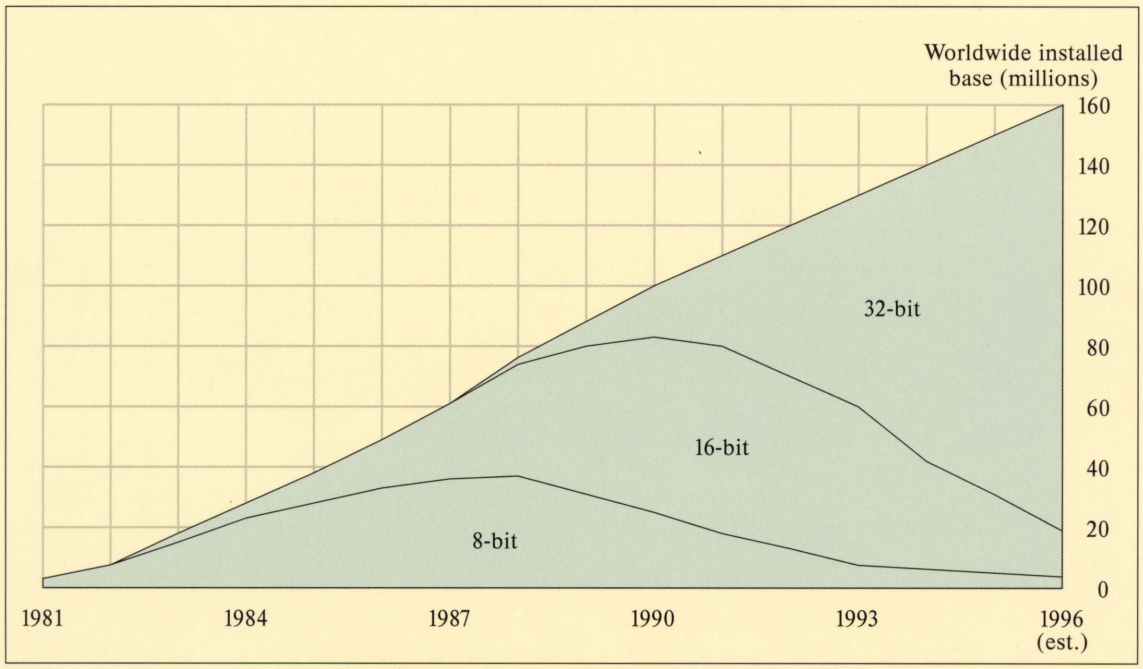


Figure 9
The Invasion of 32-Bit Machines

Parameters	Limiting phenomena	Value	Corresponding minimum design rules	Possible remedy
Gate oxide thickness	Tunnelling	3 nm	50 nm	New dielectrics
Channel doping	Statistical fluctuations	100 atoms	100 nm	New transistor architecture
Interconnects	RC electromigration	10 ps/cm	100 nm with Cu	Asynchronous circuits New conductors
Operating voltage	V_t fluctuations	1 V	50 nm	Low temperature New V_t control
Energy per bit	Thermodynamics	5 eV	10 nm	Low temperature

Source: EC DG III

Figure 10
Physical Limitations to Deep Submicron VLSI

Figure 11

Years	1985	1988	1992	1995	1998	2000	2003	2005	2010
Critical dimension	1 micron	0.8	0.5	0.35	0.25	0.18	0.15	0.12	0.1
Standard operating voltage	5 V	5 V	3.3 V	3.3 V	2.5 V	2.5 V	1.5 V	1.5 V	1.2 V
Low power systems	3.3 V	3.3 V	2.5 V	2.5 V	1.5 V	1.5 V	1.2 V	1.2 V	1 V

Source: EC DG III

2.1 The Limits of Silicon Integration

What are the limits of silicon integration technology? Two main aspects have to be considered: the physical limits behind shrinking and the manufacturing limits due in particular to the lithographic techniques and to the quality of the production environment. The physics limits (see *Figure 10)* include the ultimate scaling for MOS transistors (tunnelling effect, doping, etc), interconnect and low-temperature issues, speed and power dissipation, low-voltage operation, the low capacitance transistor, and fully isolated structures.

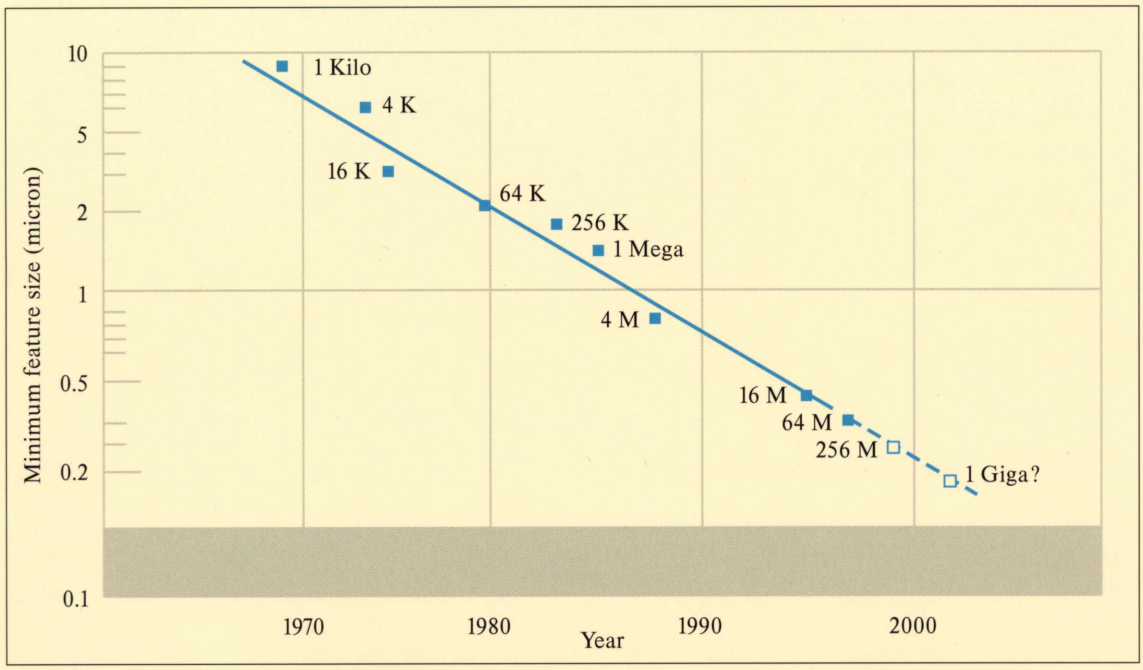
Figure 11 presents the past evolution of the operating voltage, in comparison with the thickness of the component. It is possible to foresee forthcoming evolution in terms of dimensions and operating voltages.

Figure 12 shows the historical evolution of the minimum size of a component (in this case a DRAM). The shrinking factor is about 1.15 per year (that is, 15% per year).

As shown in *Figure 13,* the ultimate MOS transistor thickness for high performance at room-temperature operation is in the range of 0.1-0.05 micron (see Ref.: [DGIII-1]). This means that the conventional MOS transistor might shrink down to 0.1 micron. At this level, it becomes necessary to increase carrier speed in order to allow the acceptable transistor capacity, using suitable heterostructures.

The interconnect issue represents a severe limitation of circuit performance, but the experts do not expect to reduce the interconnect capacitance, owing both to power capacity and to additional delays. Interconnects are much more difficult to shrink in the nanometre range without losing speed. However, there is still some scope for innovation in this field, in particular through joint circuit architecture/technology research: one must avoid transmitting high-rate information over long distances during one clock period. Time and delay management similar to those applied in telecommunications networks should be used.

The fabrication of large scale IC's requires not only pattering with high resolution, but also overlay accuracy, critical dimension control, uni-



Source: EC DG III

Figure 12
Shrinking Factor: 1.15/Year

Device physics for large number of MOS transistor	0.1 micron
Performance of interconnects	Limiting below 0.25 micron
Optical lithography	0.15–0.12 micron
Economics: maximum Fab-cost allowable 10 B $	0.15–0.12 micron

Source: EC DG III

Figure 13
Summary of the Limits for Ultimate CMOS

formity on large dies and wafers, low defectivity, high throughput, etc. For the future generations of IC's, numerical values are given in *Figure 14*.

What is the ultimate complexity that a CMOS plant will be able to manage? Going from (1) device to (N) devices per die, and then (N x n) per wafer, and finally to (N x n) x m per month is the key issue in integration technology.

CMOS manufacturing is based on optical lithography, the limit of which could be about 0.12 micron.

If the previous general trend in size reduction continues, this means that we do not know the tools to be used within 10 years from now. Taking into account the cycle time from research to production, this is a major concern. Indeed, if shrinking starts to slow down because of that

Figure 14
Lithography Requirements for Deep Submicron Integrated Circuits

Years (beginning of production)	1965	1998	2002	2006
Product generation	64 MBit	256 MBit	1 GBit	1-4 GBit
Minimum geometrics (micron)	0.35	0.25	0.18	0.15
Critical dimension control (micron)	0.08	0.06	0.05	0.05
Overlay (micron)	± 0.1	0.08	0.06	0.05
Field size (mm)	25 x 25 mm	30 x 30 mm	30 x 30 mm	35 x 35 mm
Dies/field	2	2	1	1
Depth of focus (micron)	0.5-0.7	0.3-0.5	0.2-0.3	0.1-0.2

Source: EC DG III

bottleneck, IC's could continue to progress through the use of larger dies and 3-D structures, but then the cost and quality issues will be even more stringent.

If one takes into account the specific requirement of VLSI-ULSI that a large number of devices operate properly within an integrated circuit, the statistical rules and maximum allowable leakage currents might fix the ultimate CMOS technology somewhere around 0.1 micron.

A careful semiconductor market and fab cost study should be made to define the ultimate integration technology: if a $ 10-billion factory cost is economically acceptable, this would put the limit somewhere in the 0.15-0.12 micron range, i. e. 4-10 Gbit memories.

2.2. Quantum Components

On the ultimate CMOS miniaturisation scale, the microelectronics is dominated by different physical laws, such as quantum mechanics. Below the length scale of 20 nanometres, the drift diffusion model used to describe carriers transport in semiconductors is no longer valid, and it is necessary to consider the effects of quantum physics.

In a semiconductor, the intrinsic quantum mechanical length scale associated with carriers is regulated by the "de Broglie" law (see *Box 1* and [DGIII-1]).

For typical semiconductors at room temperature, wavelength is normally about 20 nanometres: in this condition, electrons travel ballistically between collisions and it is necessary to use quantum models in order to be able to understand and to describe the new phenomena. The

IT industry can now prepare multilayer semiconductor crystals with a precision of 1 nanometre for layer thickness.

The quantum phenomena arise by constraining the motion of carriers, that is, reducing the thickness of sandwiched layers.

The present methods used for the growth of semiconductor multilayers, namely the MBE (Molecular Beam Epitaxy) and MOCVD (Metal-Organic-Chemical-Vapour-Deposition), are able to manage layer thickness at the nanometre scale. In such a way, it is possible to atomically engineer abrupt heterojunctions or doping profiles.

In semiconductor production and research, four generations of quantum components are considered.

The *first generation* includes devices produced and used in high volume, such as HEMT, High Electron Mobility Transistor, the QWL, Quantum Well Lasers, and HBT, Heterojunction Bipolar Transistors. Even if the quantum mechanism is not used in the current HBT devices, ballistic motion is going to be used in the base region of these semiconductors. The first generation devices are widely used:

- HEMT for high-speed digital signal switch and for low-noise amplifier (for instance, in direct broadcasts via satellite);
- QWL for semiconductor lasers, as a natural extension to the double heterostructure laser;
- HBT for power-device applications, in small-scale IC and for portable telecommunications, as an evolution of the "traditional" FET (Field Effect Transistor).

The *second generation* represents a refinement of the first one and introduces the pseudomorphic HEMT, the vertical cavity surface emitting laser, the new microwave components. All these devices operate at a scale of less than 10 nanometres.

The *third* and *fourth generations* are still in the research field and cannot be considered close to the market yet. The third generation includes quantum electronic components on the 10-20 nanom scale which utilise resonant tunnelling and the associated negative differential resistance in double-barrier diodes. The principal applications envisaged to date are:

- sources of millimetre-wave radiation above 100 GHz;
- mixing and detection elements for such radiation;
- the provision of added functionality in transistor and other devices.

The fourth generation represents the new age of the "microscopic" physics which deals with a few carriers. The addition of lithography and etching techniques allows quantum confinement in two or all three spatial dimensions, and the carrier transport has a one or zero-dimensional character.

This specific research segment is named "mesoscopic" physics and includes effects such as quantisations of the ballistic resistance, quantum interference and coulomb blockade phenomona.

Quantum components represent the future of mainstream electronics: molecular electronics and all-optical computing are different alternatives in the strategic research arena, but they have yet to master the complexity and the completeness of semiconductor circuits and systems.

Figure 15 shows an overview of the emergence of quantum electronic components.

Figure 15
Examples of Quantum Electronic Components

Generation	Physics	Device Types	Feature Exploited	Operational/ Production Timescale
1st	Quantum confinement, 2D Dos, blue shift	QW laser	Low threshold current density, structure-tunable wavelength	In production
	Quantum confinement, spatial separation of carriers	HEMT	Low noise, higher speed, less dependent on temperature	In production
2nd	Greater quantum confinement	P-HEMT	Lower noise, even higher speed	In Production
	Hot electron injection	Heterojunction Gunn diode	Higher efficiency, lower noise, less dependent on temperature	In production
3rd	Tunnelling	ASPAT	Less dependent on temperature	Prototyping 1 year to market
	Resonant tunnelling	Diode as source/mixer low power	Very high speed, high efficiency, possible high	Highly special applications so far. Bandwidth links in space/on earth > 10 years
4th	Ballistic motion, quantum reflection	Split-gate transistor as terahertz source/mixer	Ultra-high speed, very low power	Possible high bandwidth links in space/on earth > 10 years

Source: EC DG III

Box 1

De Broglie law

$\lambda = h/p$

where

λ = de Broglie wave length
h = Planck's constant
p = carrier momentum

and p is related to the electron mass "m" and the temperature "T" by:

$$p = \sqrt{(2\,k\,T\,m)}$$

where k = Bolzmann constant

The energy (E) of a photon is: $E = h\,v$

where v = radiation frequency

2.3. Photonics

Photonics is generally defined as a technology where photons and electrons perform functions now normally performed by electronics. In terms of physics, the photon is a specifiable quantity of electromagnetic energy.

Electro-optical devices are widely diffused in telecommunications, in particular in optical transmission, storages and displays. Most of these devices are *"discrete"*, such as silicon photodiodes.

A new set of opto-electronic devices are *"integrated"*, in order to fully utilise the advantages of the optical environment - high bandwith, zero capacitance - integrated with the "traditional" electronic chips. The "integrated" photonic chips are still in a R&D stage, but an R&D oriented to market products.

The main areas of application are "photonic" switching, HDTV, videoconferencing, optical processing and computing, optical interconnection of VLSI and boards, etc. Consumer electronics is also going to use photonic devices, such as the low-resolution Charge-coupled devices (CCD) for camcorders.

Current optical transmission systems perform amplification and switching of optical signals in the electrical domain: the goal is to remain in the optical domain by means of suitable optical amplifiers and switches.

The main directions for photonic switching are "guided-wave" photonics and "free-space" photonics. Directional couplers are the key elements for guided-wave photonics: even if they do not work at high speed, they switch traffic through alternate links. Some devices of this type are now available on the market. Free-space switching allows massive parallel interconnections, and different techniques are used and/or investigated, such as SEED (Self-Electro-Optic Effect), and PNPN.

Quantum physics is very often applied to this field.

2.4. The Microprocessor World

At the present time, the attention of operators is focused on the following microprocessor types: CISC, RISC, DSP, Fuzzy Logic.

CISC means Complex Instruction Set Computers, because they use a complex set of instructions which require several clock cycles to execute.

RISC, Reduced Instruction Set Computers, utilise the most recent developments. In their memory, access time is now as fast as logic execution. Instructions can be transferred out of the processor microcode and into memory, reducing the number of clock cycles (normally one or lower than one).

DSPs, Digital Signal Processors, are designed to perform certain operations, such as multiplication, at extremely high speed, and in large, repetitive numbers. For instance, DSPs are ideally used for signal or scientific processing, where large amounts of data need to be processed in a standard fashion.

Fuzzy Logic was developped more as a type of application than as a specific processor, but this application logic is now going to be embedded in silicon.

Currently, CISC is the dominant form of microprocessor. The most well-known application for CISC processors is the personal computer, where CISC processors have a virtual monopoly. Of the two dominant computer architectures, IBM-compatible PCs are controlled by the Intel X86 microprocessor series, whereas Apple PCs are controlled by Motorola's 68XXX family. However, CISC is also used for other applications, including the automotive (ABS, steering), military (instrumentation, engine control), consumer-electronics sectors. This course is now set on a convergence with RISC computing. The latest Intel product, the Pentium, is upwardly compatible with preceding Intel offerings, such as the 386 or the 486. However, unlike these processors, Pentium offers many RISC features, including superscalar processing, and execution times lower than one clock cycle.

RISC is best known for the workstation applications it supports, where RISC's speed is clearly beneficial. However, RISC should begin to penetrate significantly the desktop market in the mid-1990's as the scheduled PowerPC architecture begins to be deployed.

DSP, Digital Signal Processing, is a technology for processing and converting analog signal into the digital format.

Coming from Industrial Process Control, DSPs today are available for PCs at reasonable prices, giving them the power of large, expensive instruments and improving the development of new applications with digital audio/video manipulation and processing. The key applications for DSPs include telecommunications, image processing, signal processing, speech processing and engine control. Within these segments, the fastest growing is by far the image processing segment, where DSPs are being placed within desktop computers and workstations to provide new graphics capabilities. Telecommunications continues to be dominant, however, owing to extensive use in mobile communications and high-speed communications.

Fuzzy Logic does not refer so much to a microprocessor type as it does to an implementation, and its performance advantages reside mainly in speed of response (real time), stability and smoothness of operation. Whereas the Boolean logic utilised in most microprocessor systems relies on "true" or "false" statements, Fuzzy Logic allows more gradual transitions between various states as well as allowing combinations of membership in several states. This is ideal for many applications such as engine control, or white goods. In addition, costs are lower, owing to lower manufacturing costs and to the fact that software development is faster and easier and can be handled frequently by non-specialised staff. For the time being, the added-value of Fuzzy Logic consists of software and development tools, making use of a near-standard microprocessor, typically of 8-bit type. However, specialised Fuzzy Logic processors are expected in the near future.

Undoubtedly, one of the significant trends in the 1990s will be the proliferation of application specific-microprocessors, ASICs. The reasons for this proliferation are the needs for OEM product differentiation and for portability. Furthermore, these application-specific microprocessors provide OEMs with the opportunity to recapture some of the added-value within their products. In many cases, the ASIC microprocessor will not be user-programmable, so software will become the domain of the OEM. Typically, these ASIC solutions combine the technologies of a microprocessor house and an ASIC vendor.

3. EDP Systems

The generic term of EDP (Electronic Data Processing) is no longer strictly related only to data processing but is increasingly used as a synonym for information technology.

As a general consideration, the state of the art presented in the last report has been confirmed, and in particular, the following points should be noted:

- the growing use and role of the personal computer and the consequent success of client-server logic;
- the growing availability of multimedia systems and devices;
- the key role of software and the growing acceptance of "object-oriented" programming;
- the growing "complexity" of the "information system" and the consequent need for powerful and easy-to-use "integrated" management systems.

It is important to recognise that, in the space of three decades, the shape of "computing" has been transformed completely, thanks to steady improvements in IT technologies and the maturation of the end-user and of the market. *Figure 16* shows the key items of such an evolution.

3.1. Computer Technology and Hardware Products

The proliferation of product and system announcements in all segments of computer technology confirms the dynamic evolution of the market, but it confuses both the user and the buyer.

Very large and large-scale systems

The mainframe still exists, but as a central "repository" or "data server", in the now conceptually dominating "client-server" logic. The mainframe is changing from both the architectural and the technical points of view: from the "traditional" air or water structures, such as the IBM/370 and /390, to a "new mainframe", based on RISC parallel processors. The technology of parallel processing (for details see the last report) is available and it makes it possible to drastically reduce the cost per MIPS and, overall, the management cost of the whole system. The key problem of the new "RISC mainframe" is the "continuity" with the "old mainframe", in particular in terms of operating systems and applications. The trend is clearly towards Unix and new "client-server" applications. But the large investments made in the present applications have to be saved, and therefore, the new mainframes will be able to support both the old and the new environments.

Medium-scale systems

The "revolution" of RISC parallel processing has an impact on medium-scale systems too. And all the concepts depicted for mainframes apply also to them. This segment is suffering from the pressure of both the server/workstation and the "new mainframe": but it is on the contrary favoured by downsizing from mainframes. The market confirms that these systems are dedicated to specific functions and features, such as online transaction processing and the fault-tolerance system.

Figure 16
The Four Paradigms of Computing

	Batch	Time Sharing	Desktop	Network
Decade	1960s	1970s	1980s	1990s
Technology	Medium Scale Integration	Large Scale	Very Large Scale	Ultra Large Scale
Location	Computer Room	Terminal Room	Desktop	Mobile
Users	Experts	Specialists	Individuals	Groups
User Status	Subservience	Dependence	Independence	Freedom
Data	Alpha-numeric	Text, Vector	Font, Graphs	Script, Voice
Objective	Calculate	Access	Present	Communicate
User Activity	Punch & Try (Submit)	Interact	See & Point (Drive)	Ask & Tell (Delegate)
Operation	Process	Edit	Layout	Orchestrate
Inter-connect	Peripherals	Terminals	Desktops	Palmtops
Applications	Custom	Standard	Generic	Components
Languages	Cobol, Fortran	PL/1, Basic	Pascal, C	Object Oriented
Relative Cost of Computation	10,000	1,000	100	1

Source: EC DG III

LAN servers and superservers

The growing niche of LAN servers and superservers can be considered, from a technological point of view, as a specialised sector that combines mainframe/mini logic with PC design and processing. This sector, too, is dominated by RISC and by parallel processing. In this context, two evolutionary trends have come to light:

- communication servers able to interface different types of networks, and in particular, high-speed networks, for instance, with frame relay interface;
- servers able to deal with multimedia information; they normally have to manage large amounts of data, and therefore, they use RAID (Redundant Array of Inexpensive Disk) solutions.

PCs and workstations

The differences between PCs and workstations are disappearing: the technology is the same, CISC or RISC-based, and any difference is due to the different configurations and the different peripherals used. The PC/WS is therefore a box specialised by the different boards plugged in, where "bus compatibility" assumes a key role.

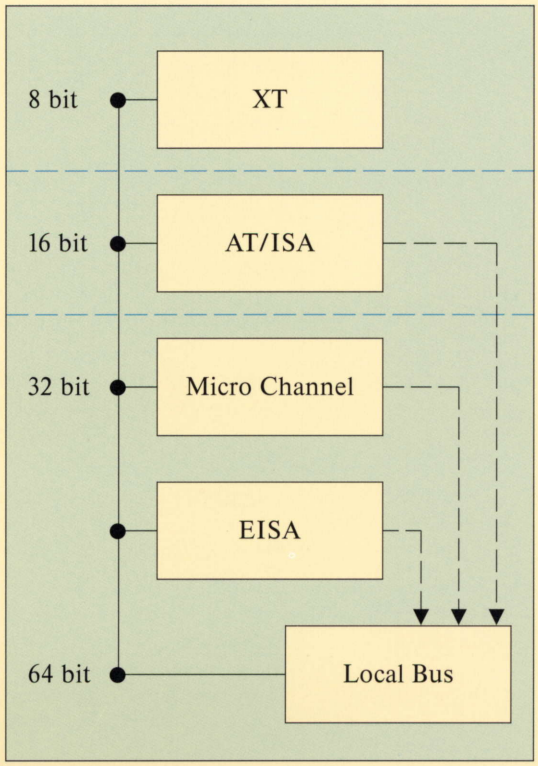
The internal bus of a PC architecture manages communication among all the components of the systems, such as CPU ROMs, RAMs and peripheral drivers: bus capacity directly influences PC performances. Bus evolution corresponds to the evolution of the PC, as illustrated in *Figure 17.* Nowadays, the industry-standard buses are ISA, EISA and MCA.

ISA, Industrial Standard Architecture, has been introduced by IBM and is the most widespread, even if it operates at 16 bits. ISA speed is about 16 Mbps (2 MB/s).

EISA, Enhanced ISA, is compatible with the ISA and with the considerable numbers of AT cards: EISA also provides a 32-bit channel for addressing and includes a local memory and an I/O processor which manages intelligent peripheral signals, thereby reducing the CPU load. EISA speed is about 264 Mbps (33 MB/s).

MCA, Micro Channel Architecture, has been introduced by IBM for PS/2 environments and operates at 32 bits, but it is not compatible with the ISA world and its speed is about 160 Mbps (20 MB/s).

Further innovations in buses are the forthcoming "Super EISA" and the "MCA II", which will improve the bus performances, and the introduction of the *local bus.*



Source: SMAU

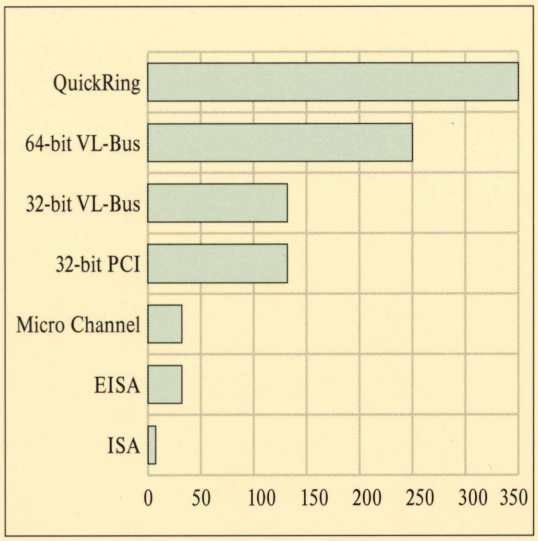
Figure 17
PC Bus Evolution Tree

Local buses

A meaningful evolution of the PC system architecture is the introduction of the "de facto" standard *"local bus".*

Some peripheral drivers, and in particular, video cards and the hard-disk controllers, work at a fraction of the available bus speed and therefore create critical bottlenecks. Several EDP manufactures by-passed this problem by connecting these peripherals drivers directly to the CPU by means of a *local bus,* up to now proprietary designed. The lack of a standard reduced the creation of independent "add-in cards" for the many proprietary local-bus designs.

Figure 18
Rated Bus Performance



Source: Byte

At the present time, three "de facto" standards are appearing on the market:

- VESA's (Video Equipment Standards Association) VL-Bus;
- Intel's PCI (Peripheral Component Interconnect);
- Apple's Quick Ring.

The performances of these local buses are compared with internal buses in *Figure 18.*

VESA is a consortium of more than 120 IT companies, and it has defined, with VL-Bus, a "de facto" standard interface for a local bus chip and a "slot" concept that allows expansion boards to use both the VL-Bus and the "traditional" ISA, EISA or MCA concurrently. The VL-Bus specifications are loose, in order to encourage the innovation of both add-in card and motherboard designers. VESA has also defined a 64-bit data-bus version of VL-Bus, to achieve the 64-bits architectures of the new processors. VL-Bus uses 32 (or 64) bits for carrying data, and 32 for addressing. It has been designed in the "old" context of the AT PC with the aim of solving its bottleneck problems for the start term.

PCI and Quick Ring provide a more advanced and strategic view. PCI is the Intel specification for the local bus and it defines an interconnect topology based on only one set of 32 pins that carry both data and addresses. Whereas VL-Bus might be produced by board manufactures, PCI makes it necessary to design and produce a specific IC.

Quick Ring provides meaningful innovations and an incredible increase in speed, as *Figure 18* shows. Quick Ring is based on a twisted-ring topology and uses low-voltage signals. All the other internal or local-bus architectures work with TTL signals, whose voltage range is between 0 V (low) to more them 2.4 V (high). And this requires high-impedance circuits and for 32 + 32 bus lines high power dissipations, with all the related cooling problems. Quick Ring uses a very low voltage, for each bus line, much lower than 1 V peek to peek. Special amplifiers convert TTL voltage level to the Quick Ring voltage level and vice versa. The twisted ring topology introduces LAN and "token" logics into the bus context: each peripheral is a "node" and a channel is opened with the CPU for the data-token exchange. Quick Ring provides a very high speed, but the token approach is more complex and introduces an high overhead, reducing the usable bandwith.

Portable and hand-held computers and personal digital assistants

The broad area of portable, hand-held, pocket and pen-based computers (which also includes office products at the top level, such as organisers, data banks, translators, calculators, and so on), has a unique, common and final goal: an integrated pocket device that includes the functions of a pen-based PC, of an intelligent organiser, and of a mobile terminal for voice, data and images (at least as a fax). Nowadays the portable environment contains three size factors: the notebook, the palm-top and the pocket computer. The preference for one portable system over another is not a question of size, but is one of functional requirements.

The pocket computer/PDA (Personal Digital Assistant) is normally based on 8086 or i386sx architectures, and it will operate at 1.5 volts, resulting in low power consumption. Certain products are currently on the market, such as the Newton from Apple, the EO of Olivetti and PEN PAD PDA 600 of Amstrad. Owing to their limited functions, all of the current products can be considered as prototypes of the future integrated personal system. But they indicate that all the necessary technologies exist and they are testing market responses.

The main specific technologies required to support this personal system are:

- mobile telephone/fax communication techniques and protocols;
- low power-consumption semiconductors (see also Chapter 2.1.);
- pen environment techniques, such as:
  - digitiser for identifying pen position on the screen; the information between pen and screen is usually exchanged via very-low-power radio frequency;
  - hand written recognition, that can be "content-free" when operating at character level or "content-sensitive" when operating at script (cursive) level and using surrounding letters and/or words to improve recognition;
- speech synthesis for vocal answers to the user;
- speech and signal recognitions, that can use different technologies such as neural nets, Fuzzy Logic or case-based logics;
- improved screen ruggedness; current fragility of the LCD displays is critical in the direct interaction between the user and the screen via a pen.

For more details, refer to the comprehensive analysis of "Mobile Computing and Communications" in Part Two.

Video display techniques

As explained in EITO '93, active matrix, passive matrix and LCD are the main technologies for the screen. Colour screens are more and more used for GUIs, Graphic User Interface, and the needs of computing power to deal with GUIs are growing. One solution is provided by the introduction of GUI accelerators, intelligent boards specially created to improve video management speed without increasing CPU load. The widespread diffusion of Windows has accelerated the need for efficient monitors and powerful processing. A Super or Ultra VGA deals with 1,024 x 768 pixels, with 8 bits of colour per pixel (256 colours).

High level monitors are now able to manage 1,280 x 1,024 pixels, and with 24 bits of colour per pixel, which allows a palette of 16,777,216 different colours. This requires a lot of processing capability, difficult to achieve, even with 486 at 33 or 50 MHz: a coprocessor dedicated to the video management and suitable compression techniques, such as the JPEG algorithm are now the most advanced solution.

Multimedia systems

The technologies used for multimedia systems were described in the last edition, which should be referred to for a technical overview. Using those technologies, many new products/devices are emerging on the market. At the moment, a widespread diffusion of these systems has still to occur; and the main problem is not the "cost" of the specific device, but the cost of the PC/WS necessary to support the multimedia; in fact, it requires high- speed clock, a high-performance CPU and a lot of RAM. In the last year, three salient events occurred: the introduction of a new full-motion standard, the MPEG, Motion Picture Expert Group, the development of speech synthesis and speech recognition boards, the introduction of optical storage systems like CD-ROM and CD-XA.

MPEG operates within CD-I, Compact Disc Interactive, in order to provide the "full-motion video", which makes it possible to store pictures on the CD-I at the TV-quality level. CD-I has been designed to connect to home TV sets and to hi-fi systems: with the definition of the ISO international standard MPEG for "full motion", the CD-I could be an alternative to videocassettes, being able, moreover, to be interactive, to support videogames and Photo CD Systems. Some manufacturers have just delivered the first board developed according to MPEG, that can be utilised on present CD-I systems for full motion.

MPEG 2 is in the course of standardisation, with the aim of increasing the data rates and being utilised also for on-line interactive TV (see also below).

3.2. Architectures

The continued and highly dynamic evolution of technology, market and business needs requires a constant re-thinking of the whole information system. As discussed in detail in the previous '93 report, the key strategic issue is the definition of a Comprehensive Enterprise Architecture, able to balance the introduction of innovative technologies with the "continuity" of information services and the assets of and investments made by the Company. In the EITO '93 report, the focus was on "open systems" and on all the related "de jure" or "de facto" standards. This year, the focus is on the "client-server" concept and on the security of information systems.

Client/server architectures

The term "client/server" is used more and more often as an approach or a logic or an architecture, frequently without a precise knowledge of the real meaning of the concept. It is also used in conjunction with or as a synonym for "cooperative processing" and "open system". The "client/server" concept can be described as an applications of networked, cooperative processing in which the end-user's interaction with the computing environment is through a programmable workstation that executes some portion of the process. An architecture of this kind is based on the concept of using some machines as "servers" with resident service programmes and data (file management and updating, network management, etc). At the same time, user machines work as "clients" of the server, asking them to perform particular services. *Figure 19* shows the basic concept of the "client/server" logic and the relationship between client and server. Therefore, there is something like a "super operating system" containing the directory list of all files and programmes resident in the computer network. Architectures of this type need to be able to process information in parallel, subdividing the work

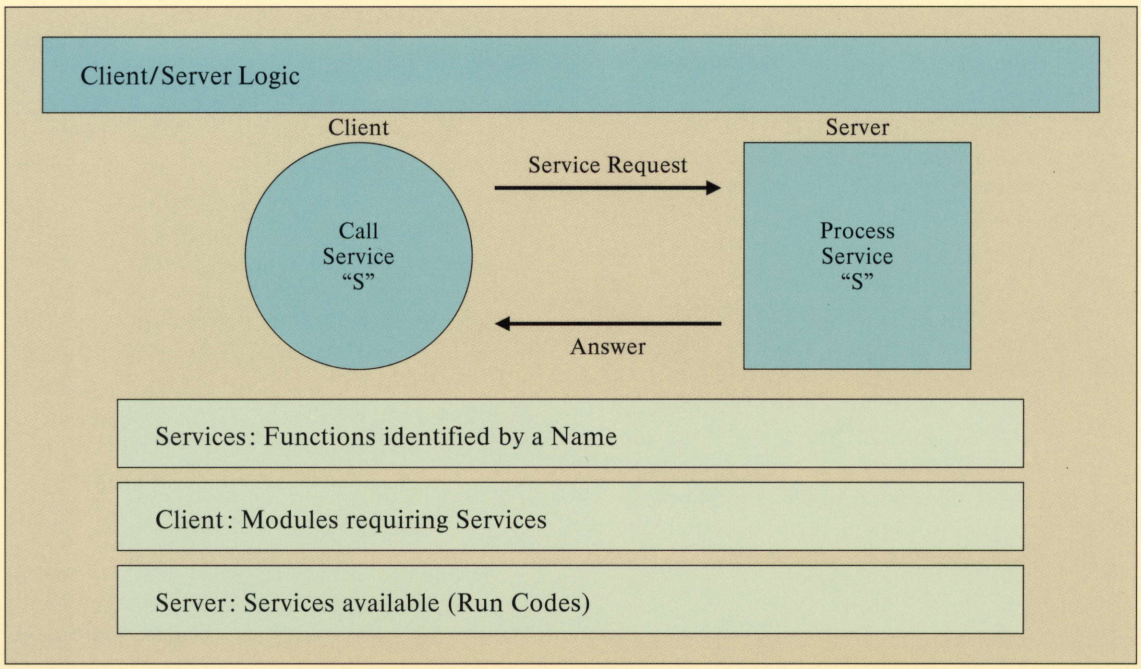


Figure 19
Client/Server Logic

Source: SMAU

between the "client" and the "server". The advantages of an architecture of this kind clearly lie in its great flexibility. The local residence of data offers advantages in terms of speed and performance, while the global management of data offers advantages in terms of integrity and synchronisation. Flexibility also implies the possibility of adding new resources or changing some existing resources without having to re-design the whole system.

Most organisations are now focusing on streamlining their business strategies and realising cost saving through the replacement of rigid hierarchical structures. Organisations must direct themselves towards a constantly changing environment, being able to respond to market forces in very short time-scales.

Client/server architectures are ideal for these new requirements of business context users.

The "client/server" approach has the greatest impact in a future cooperative, knowledge-sharing organisation, where it can be used to distribute the components of an application over a range of computers, each one suited to a particular task. In client/server systems, the functions of an application, which may be multimedia, are transparent to the user and serviced by communication, database, and other servers. Each division of activity creates clients and servers, with different characteristics and styles of use. In this way, computing resources can be optimised to suit the requirements of a particular activity.

There are two basic components in any client/server environment: services and Application Programming Interfaces (APIs).

The services can be subdivided into layers, and include:

- distributed operating facilities (network operating systems);
- middleware facilities, that provide "re-usable" services for the user, such as systems management, database management, transaction processing, file services, E-mail, printing, document management, etc;
- user applications.

APIs are the basic mechanism through which the application requests the use of a service. They provide a separation between application and services, allowing a "plug-and-play" approach to system integration. APIs also provide "independence" between applications and platforms (hardware, operating system and middleware).

The client/server architecture requires a profound change in application development: in this context, the "old" application has to be divided into two "new" applications, one on the "server" side, the second on the "client" side. In many cases, the server part is mainly a database manager, transparently accessed by the client application across the network. New applications are also stimulated for coordinating the operation and hiding the limits of old but business-critical applications written for old platforms. Furthermore, the client/server logic has considerable implications for the future of system and application developments: object-oriented analysis and programming (OOA and OOP), 4GLs, new CASEs, distributed database and multimedia contexts are emerging in a bus-string fashion.

The security of information systems

With the increasingly pervasive usage of computers in all contexts and activities, the security of information and of the systems that manage the information is becoming of great importance and interest for individuals as for commerce, industry and public administrations. Correspondingly, the protection of information in all its aspects, often named "information security", has become a central policy and technological issue.

The EC "Green book" [GB] presents the following definition:

"... *Information security* is concerned with the protection of information stored, processed or transmitted in electronic form, against deliberate or accidental threats.

Information is acquired, communicated, processed and stored by information services. Electronic information services need a secure communications infrastructure, secure terminals (including processing and databases) as well as secure usage. The management of the service provision itself must also and foremost be secure ..."

The security of information systems can be defined as the protection of the requirements of *integrity, availability and confidentiality* of the information and of its processing.

The security of information systems is now approached as a *"global"* and *interdisciplinary* issue, strictly related to the business strategy ("absolute" security has no meaning; it is always "relative" to the business strategy) and implemented in a dynamic fashion: IT evolution modifies both the possible defense systems and the possible attack systems. Information security affects technological issues for physical and logic security, strategic, economic, organisational, associative and legal issues.

For the security of information systems, two important activities, with the consequent results, have been implemented:

- the definition of standards in the OSI context;
- the definition of criteria and rules for the security evaluation of IT products.

The OSI Security Architecture (IS7498-2) defines guidelines and constraints in order to improve existing standards or to develop new ones. It deals with different types of attacks, especially concerning data-processing and/or data communication environments such as trapdoors, Trojan horses, modification of messages and masquerades. It also gives a list of services that can be provided within the framework of the OSI Reference Model. Those services can be grouped into five classes that can be considered as the basic or "primary" ones:

i. *authentication:* a guarantee that an entity is not attempting a masquerade or an unauthorised replay of a previous connection;
ii. *access control:* provision of protection against unauthorised use of resources;
iii. *confidentiality:* protection of data from unauthorised use;
iv. *integrity:* a guarantee of protection against unauthorised modification of information;
v. *non-repudiation:* protection against any attempt of the sender/recipient to deny sending/receiving data or its contents.

All the above services are called "specific services". Other security services are considered by OSI as "pervasive" to the entire open system; these pervasive services are trusted functionality security labelling, event detection, security audit-trail and security recovery.

OSI also defines a set of mechanisms for implementing security services. Those mechanisms are: encipherment, digital signature, access control, data integrity, authentication exchange, traffic padding, routing control and notarisation.

OSI includes the security management in the NMS, Network Management System, as one of the five System-Management Functional Areas (SMFAs): configuration, fault, performance accounting and security management. SMFA security enables the exchange and control of information related to security of all open systems. SMFA defines the set of facilities that are required in order to operate on security objects.

All the facilities within the SMFA use the functions offered by the Common Management Information Services (CMIS) and Protocols (CMIP).

ISO has also started several initiatives dealing with security for distributed applications. The directory systems standard (IS9594-1, X.500) plays an important role in most OSI applications. The directory is not only an OSI application that needs to be secure, but is also a means of distributing authentication information, besides being a means of finding available services. Incorporated in the 1988 CCITT X.400 Message Handling System recommendations is the provision for secure message-handling. This capability essentially allows for secure message transfer within the handling environment. One application of the MHS is electronic data interchange (EDI). CCITT is currently working on the recommendation for EDI that will employ X.400 security and additional security facilities to meet requirements for services not defined in the X.400 standard. The basic security features of the EDI security standards X.435 include: proof and non-repudiation of transfer reception, retrieval and content, message-store extensions and transfer audit.

The second main issue regarding the security of information systems is related to evaluation criteria for product security. Starting from the USA Trusted Computer Systems Evaluation Criteria (TCSEC), commonly known as the Orange Book, the EU has now published the Technology Security Evaluation Criteria (ITSEC) (ITSEC 91), known as the White Book, which could be considered as the beginning of European standards for evaluating computer trust. In ITSEC, a product is evaluted by virtue of its functionality and effectiveness. For evaluating functionality, ITSEC suggests ten predefined functionality classes in the range F1 to F10. Classes F1 to F5 are hierarchical and practically correspond to the Orange book's five classes; classes F6 to F10 are non-hierarchical and are specific for database, process control, exchange data integrity, high confidentiality, high confidentiality and high-integrity environments.

The effectiveness of a system is evaluated in seven hierarchical levels from the "inadequate" E0 to the "formal description" E6 . These levels are used in all the IT system life cycle, from initial requirements through the implementation to installation, start-up and operation. The White Book represents one of the most significant events in the last decade in the European IT security scenario and it might cover the shortcomings and the gaps of the USA Orange Book.

3.3. Software Technologies

Microelectronic and computer technologies are the pillars of evolution and progress in ITC, but it is software technology which will determine the penetration speed of user acceptance of solutions. Software technology has still to bridge the real gap between currently enourmous hardware capacity and the end-user's ability to use it.

During the 1990s, software is playing more and more, and will continue to play, a major innovative role by creating new solutions and generating significant changes in end-user behaviour at home and at work. Software innovations are continuous; every new development introduces innovations.

According to the statistical section of EITO, the software sector is subdivided into:

- *system software and utilities,* (also called "basic software"), which mainly includes operating systems;
- *application tools,* (also called "middleware"), which include all environment software, from graphic interfaces to communication software, relation databases and the development environment, and from languages to CASE (Computer Aided Software Engineering) tools;
- *application software,* which includes all of the software solutions for specific problems.

Standards have been and are still being defined for software technology, in particular in the fields of portability and interoperability. Certain new services and the related application software will be considered in section 5.

Operating systems

The most meaningful evolution in Operating Systems (OS) is now in the segment of desktop and network operating systems. These operating systems combine the sophisticated functions of the proprietary OS of mainframes and of minicomputers, such as multitasking, virtual memory, security, efficient system management, with the best of the PC world.

Operating systems, together with the related development environments, constitute the vehicle and the focus for competition in the PC and LAN world.

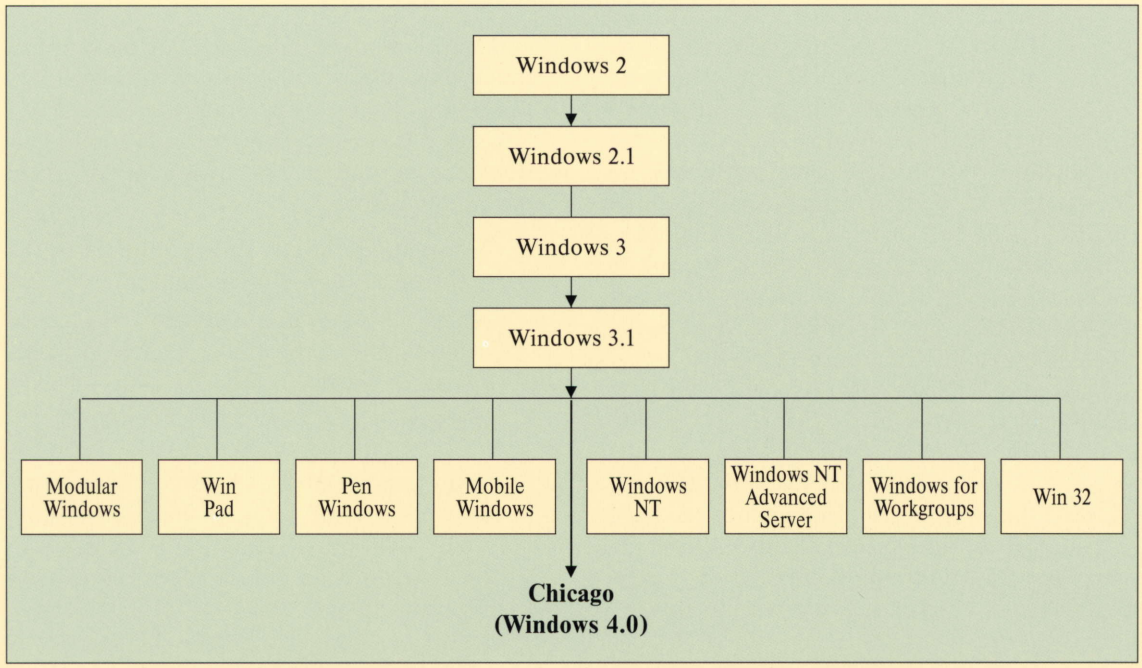


Figure 20
The Windows Evolution Tree

The diffusion of Windows and its envisaged evolution (see the evolution tree in *Figure 20*) are the reference points for the big battle now in progress, a battle that has a strong impact on users and software developers. In this arena, a different role can now be played by Unixware from Univel and Nextstep from Next.

The growing acceptance of client/server logic and the growing needs of "rightsizing" and "downsizing" mean a far-reaching change in corporate information system architectures. This change is generated by cost (mainly of the hardware and of the system management), freedom of information access, exchange and processing, and focus on both company and department-level needs.

All the proprietary operating systems have introduced or are introducing innovations, in particular as regards the cache memory, the widening of address spaces, the adoption of the new standard APIs (POSIX, X/OPEN XPG-4, etc), new security mechanisms for access control, user authentication, digital signature and data confidentiality.

Operating-system development in the near future will take the following main and interrelated directions: portability on different platforms, higher-level APIs (GUIs, networking, multiprocessing support, etc), layering into linked but autonomous objects, the introduction of microkernel logic.

The Unix world

Even if the UNIX operating system is dominating the medium-scale systems, it still does not have the market share it might, and several proprietary operating systems are still, and will continue to be widely used, even if UNIX V R.4 is now the most widely-accepted reference standard. There are two main reasons for this: the first is the "non-friendly" interface for normal users (that is, "non-technical experts"), while the second consists of the several different "dialects" of UNIX itself, which provide many similar, but different APIs (Application Programming Interfaces). UNIX also suffered from a (supposed) lack of security, now mainly overcome by release R. 4.2.

For UNIX environments, certain salient events have occurred recently:

- the new entry into the network operating systems segment of Unixware, provided by Univel, the joint venture between Novell, present leader on NOSs, and USL, Unix System Laboratories, the leader in the UNIX environment;
- the agreement among the "UNIX-like" developers to unify the different proprietary APIs into one single interface according to Posix and X/OPEN XPG4, in order to make the differences among different UNIX versions indistinguishable to the end-user;
- the general consensus of UNIX manufactures on one GUI: OSF/Motif.

The second most important evolution is GUI-based desktop UNIX: this provides very wide flexibility, with the same operating system able to range from a PC to a mainframe.

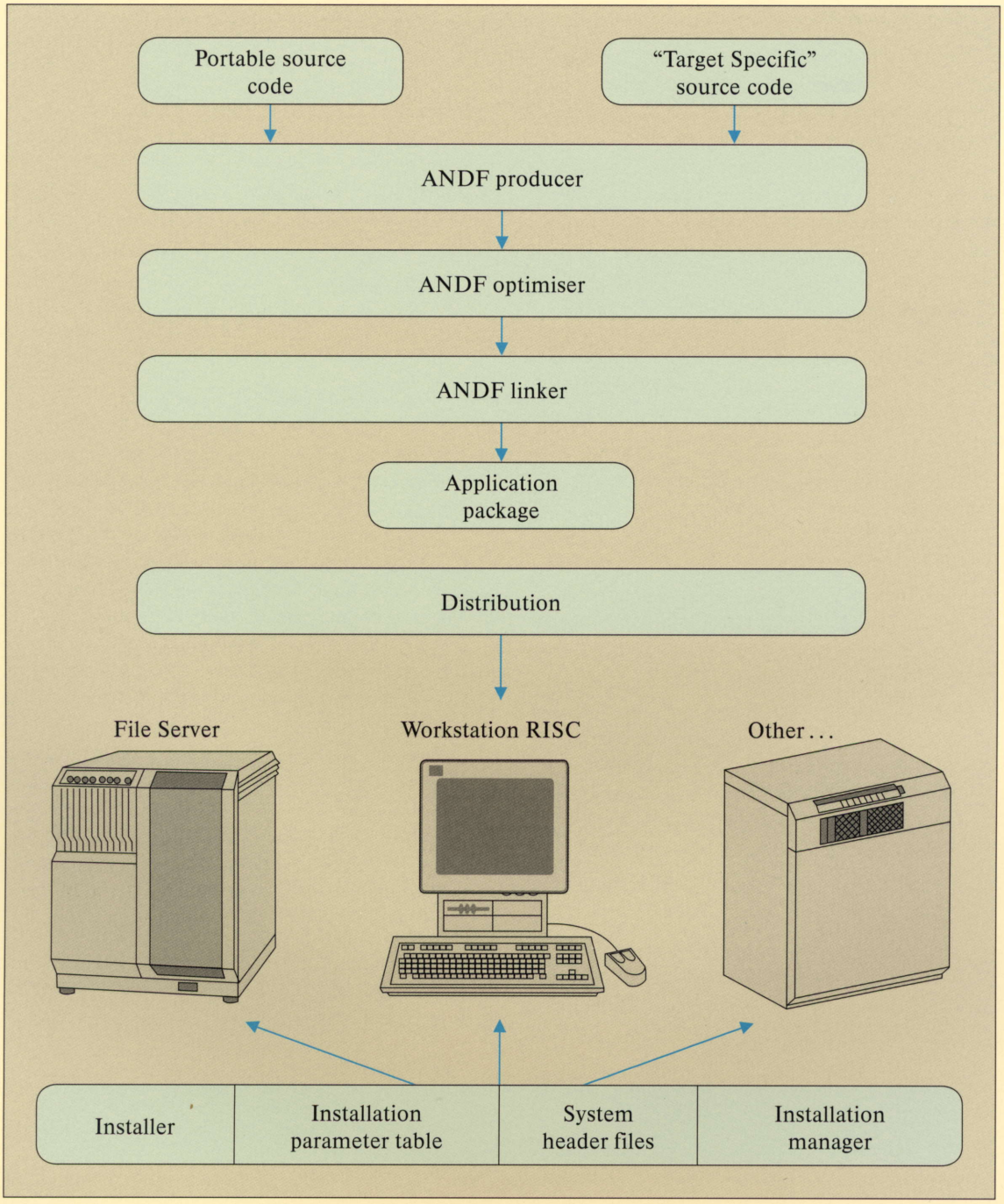
ANDF (Architecture Neutral Distribution Format)

"Portability" in open system (for instance, Posix and X/OPEN) environments has, up to now, been limited to the source code: the real need is, however, the capacity of "running-code" distribution in order to obtain the same results as in the PC world. Such results would allow a meaningful reduction of software package costs.

Two different solutions are in progress:

- ABI, Application Binary Interface;
- ANDF, Architecture Neutral Distribution Format.

The main difference between them is that ABI is hardware dependent while ANDF is independent. An ABI interface is strictly related to a specific architecture. Contrarywise, an application running code in ANDF can be installed on different processors. For example, in the Intel microprocessor architecture, ABI-compatible applications can run unchanged on different systems based on Intel microprocessors. *Figure 21* shows the logic and the components of the ANDF. It is based on a "Compiler Intermediate Language" and its main components are the "producer" and the "installer". The "producer" creates the "intermediate code" from the "source code" in the development machine; the "installer" produces the running code for the target computer, starting from the intermediate code. OSF is developing ANDF products for the C, C++ and Fortran 77 languages.



Source: SMAU

Figure 21
ANDF Structure

4. Telecommunications

For twenty years now, the IT "experts" have been highlighting the convergence of computers, telecommunications, TV and consumer electronics, and many technologies and functional integrations have been and are available, but this potential high-tech "fusion" has not taken place in a meaningful fashion. Nevertheless, all the efforts and all the technical and market failures have prepared the set of conditions necessary to ensure this convergence.

The previous EITO '93 report describes the key technologies for high-speed networks for mobile communication, cordless systems and satellites, and introduces the new services offered by the Intelligent Networks (INs).

The convergences of technologies and services that we are now facing show two main directions:

- the integration of computer and cable TV (interactive TV), capable of providing information and entertainment, for which a neologism is arising, *infotainment;*
- the integration of mobile computers, telephones and intelligent networks, capable of providing many new services, also by means of traditional terminal equipment (such as for Audiotex services discussed in the following chapter); *commuting* is the neologism often used to describe this scenario.

4.1. Transmission Media

The most important innovations about information transport media involve:

- the increasing diffusion of the optical fibres, mostly on the primary networks;
- the use of twisted-pairs, both shielded (STP, Shielded Twisted Pair) and unshielded (UTP, Unshielded Twisted Pair), also for high-speed transmission (today, up to 100 Mbps, even if over short distances);
- the use of air with different communication techniques.

For cable transmission which, in Europe, constitutes the widespread medium for data networks, optical fibres are used by WANs to the primary network connections, mostly among the central office nodes.

Today, the new challenge for optical-fibre cables involves their use in links between exchanges and users (the distribution network). From a technical point of view, experiments underway are examining both passive optics (PONs – Passive Optical Networks) with equipment that does not require a source of supply, and active optics. PONs are attracting a lot of interest, as they do not require any particular modifications to the structure of the distribution network (with all related problems), but the underlying technology is still not fully reliable. To reduce the costs of reconnecting users to optical-fibre networks, an improved network architecture is being studied which envisages the use of fibres as far as the users' premises (FTTH, Fibre To The Home) or up to a point of user concentration with short copper links to the users' premises (FTTC, Fibre To The Curb). The second solution implies a significant saving in costs.

Three kinds of optical fibres are now used: single mode, multi-mode stepped-index and multi-mode graded-index. They differ in reflection index, fibre cross-section and the use of lasers or LEDs.

Optical fibres are starting to spread in LANs, particulary for the LAN back-bone, FDDI and factory automation.

In most cases, optical fibres are not used yet by end-users, who normally have twisted-pairs or coax connections. Mostly in LANs, twisted-pairs are now replacing coax. Coaxial cable, installed in traditional data communications to link workstations to concentrators, is also the original LAN transmission media, albeit with different characteristics. The famous Ethernet "yellow" cable, the "thick" RG-8, 0.4 inch, is actually less and less used in comparison with the handier and more flexible "thin" RG-58, 0.25 inch. Twisted-pair, however, because of its wide diffusion in telephony, its low costs, and the high-speed transmission it allows, is replacing coaxial cable.

The advent of 10Base-T standard for Ethernet over UTP has significantly boosted this trend, completed by the opportunity to use the UTP for 4-Mbps and 18-Mbps token-ring networks, too. Very recent are the studies, and the interest of main manufacturers, aimed at reaching speeds up to 100 Mbps over UTP with a technique called TP-DDI or CDDI derived from FDDI.

Cordless LAN and PABX have been introduced in the market, mainly based on the European standard DECT, Digital European Cordless Telecommunication.

The increasing need for building cabling, of different kinds, as well as connections between them, has generated the need for planning and for "globally" managing the "spaghetteria": therefore, some "universal" cabling solutions have been studied and implemented.

4.2. Cable TV and Interactive TV

The shortage of frequencies is becoming a serious problem in all parts of the world. Television, radio, satellite broadcasts, as well as cellular telephones are all based on a range of frequencies which is becoming increasingly crowded, despite the great strides forward by technological innovation to make better use of the resources offered by the "spectrum" of frequencies.

The electromagnetic spectrum available for radio and television is limited and fully utilised; on the contrary, the fibre optic bandwith is very large and still remains to be completely occupied. This limitation will be the cause, in the near future, of a revolutionary change in the present transmission networks: broadcast information, at present via ether, will be delivered via fibre-optic cables, and voice information, now delivered via cables (twisted pair), will be transmitted via ether, as with the present mobile communications.

In the USA, cable television is a mature reality, and is now the main infrastructure for new "interactive" services, for instance, pay-per-view, movie-on-demand, home banking, home shopping and so on.

In Europe, only the Netherlands and Belgium have a high level of cable-TV penetration. In the 1980s, France, the UK and Germany started to introduce cable TV networks, as a part of a large-scale national TLC infrastructure. *Figure 22* shows the present situation in these countries.

The digital TV signal can be transmitted on different media, via satellite or coax, via fibre optics or twisted pair. In the USA, the present "cable TV" operates on cables, both coax or optic. In Europe, the main interest is in the "traditional" telephone twisted-pair, owing to its pervasive diffusion in telephone networks. And now, a new transmission technique, the ADSL, is emerging

Figure 22
Cable TV Diffusion

Country	January 1992			January 1993		
	Connectable Premises	Connected Premises	Penetration %	Connectable Premises	Connected Premises	Penetration %
France	3,780,000	794,000	21	4,500,000	990,000	22.0
Germany*	17,500,000	9,800,000	56	18,700,000	11,200,000	59.9
UK	1,343,557	268,812	20	1,954,829	440,162	22.5

Source: SMAU

*) West Germany

for the delivery of telephone voice, TV images and on-line interactive data on the same copper line.

ADSL, Asymmetric Digital Subscriber Loop, being studied by ANSI (American National Standard for Information), defines three channels: the traditional analog telephone channel, a monodirectional data channel from 1.5 to 6 Mbps, a bidirectional data channel at 16 Kbps.

With about 2 Mbps, it is possible to transfer compressed TV images at VHS quality level, and with the 16 Kbps, it is possible to "interact" with a central host.

This technique should be used only at the subscriber loop level, that is, in the "last mile" from the central office to the "end-user" premises. The compression technique considered is MPEG2 (Motion Picture Expert Group), already used and described for the multimedia systems, and the transmission technique should be based on multicarrier modulations with DMT, discrete multi-tone and QAM, Quadrature Amplitude Modulation.

Digital interactive TV also has a deep impact on HDTV, High Definition TV. The USA FCC will soon define as a standard the digital system, which should be based on the MPEG-2. Europe which, together with Japan, has invested in analog HDTV (standard D2-MAC and HD-MAC via satellite), is now moving towards the digital logic.

4.3. Information Superhighways

The key factor for implementing a real "digital world" is the availability of the infrastructures able to transport all the possible types of information: telematic superhighways.

Both on a national and an international level, it is necessary to build the infrastructures of the age of information, infrastructures based on high-speed/high-capacity networks that are using or will use the broad-band technologies, that is, Frame Relay, Cell Relay, ATM, etc, described in the last EITO '93 report.

The US Administration is developing the Technology Plan presented by Clinton and Gore, where the superhighways will constitute the "nervous system" of the US society in the coming years. Debate is still underway regarding the selection of the right technology for these superhighways: the ultimate medium is fibre optics,

Project	Partners	Context
Aurora	MIT, University of Pennsylvania, MCI NYNEX, Bell Atlantic, IBM Bellcore	ATM and packet switching
Nectar	Corneegie Mellon University, Pittsburg Supercomputing Center, Bell Atlantic/Bell of Pennsylvania, Bellcore	Distributed computing
VISTAnet	University of North Carolina, GTE MCNC, Bellsouth	ATM and medical imaging
CASA	Los Alamos National Laboratory, California Institute of Technology, Jet Propulsion Lab, San Diego Supercomputer Center, MCI, Pacific Bell, US WEST	Distributed Supercomputing for geology and meteorology
BLANCA	University of California, Univesity of Wisconsin, University of Illinois, Lawrence Berkely Laboratory, The National for Supercomputing Application, AT&T Bell Laboratories, Ameritech, Ford Astronautics, Bell Atlantic, Cray Research, Norlite, Pacific Bell	Multimedia and imaging

Figure 23
"Gigabit Networking" Projects

Source : SMAU

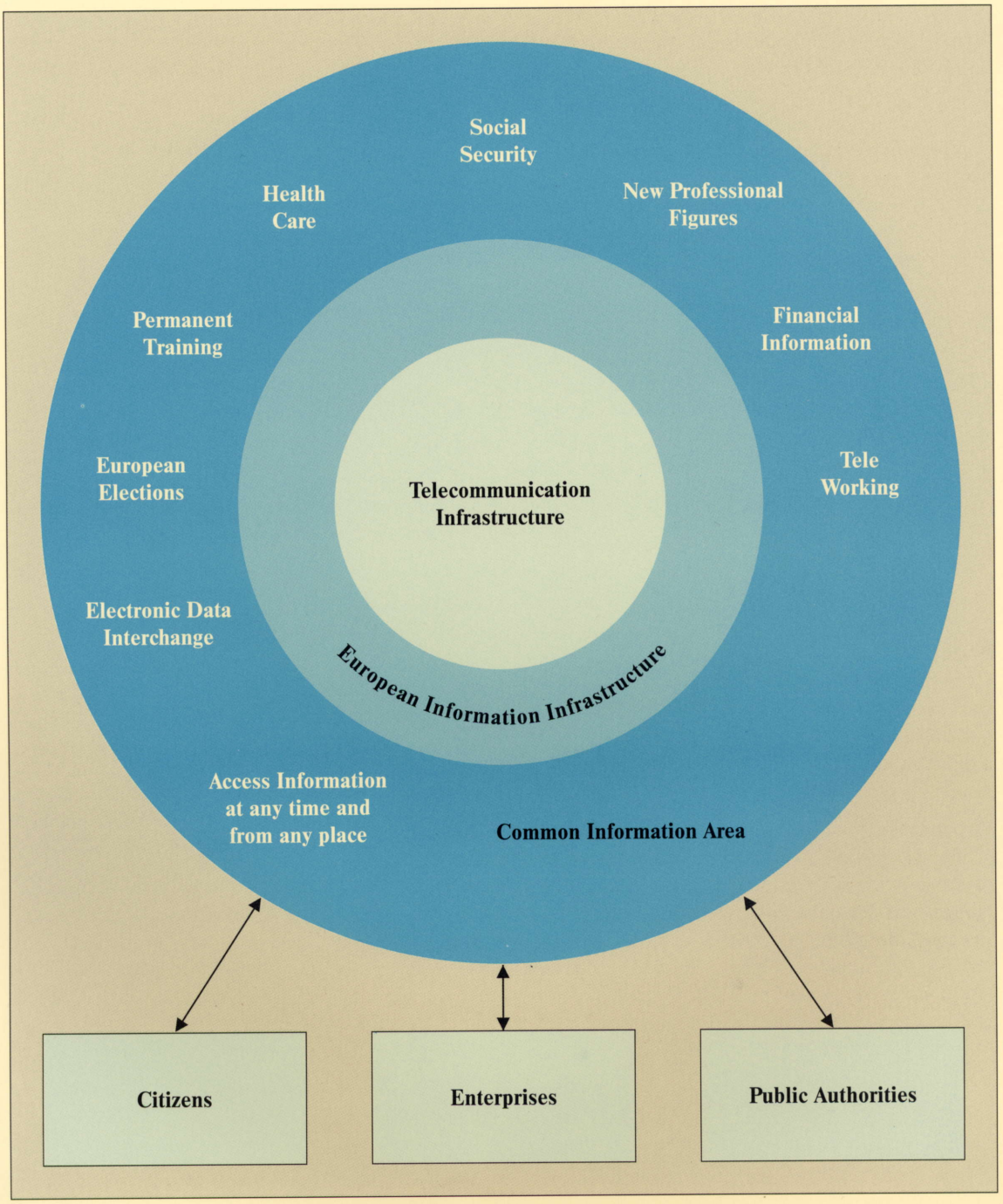
but its pervasive diffusion requires considerable investment and time. "Traditional" ISDN provides fewer functionalities and lower performance but is increasingly cheaper and it might be available worldwide in three to four years.

In any case, the USA has already started, by strengthening Internet and launching the Gigabit Networking Initiative (see table in *Figure 23* for more details).

Also for the EU, it is necessary to create a single Common Information Area encompassing the whole area of the 12 member countries. This presupposes the existence of a Europe-wide infrastructure allowing free access to and transfer of all kinds of information. The existence of such an infrastructure will free people from the obligation of geographical proximity in order to work in a team and communicate with each other with the same case and richness of information as if they were physically next to each other. It will equally allow the introduction of flexible labour organisations, enable permanent education at home and in the office, and will increase the competitiveness of Europe through improved quality of services.

The Common Information Area (see *Figure 24*) is the mechanism for accelerating the real unification of the European market, and it will reshape European society at the dawn of the 21st century.

Figure 24
European Common Information Area



Source: SMAU

The RACE and ENS (European Nervous System) programmes have identified a set of common network services, such as electronic mail, remote database access, file transfer, audio/videoconferencing which are required by all or at least a majority of trans-European vertical applications. The Telecommunications Infrastructure can be thought of as the bare bones of the Information Infrastructure because it does not offer such a set of common network services but it does represent a prerequisite for building them.

Today, there is no pan-European provider of such services, and the national situations vary widely from one country to another. Trans-European applications could, in principle, generate the demand which can justify investments to build the infrastructure. Unfortunately, there is no single overall responsibility for trans-European vertical applications: the EC Commission, member countries and the private sector all play a role and have responsibility for some applications. The catalyst can only be provided by the set of applications to be developed under the IDA (Interchange of Data between Administrations) umbrella, where the combination of EC Commission and the 12 member countries holds the power to decide the framework in which these applications are to be developed.

A meaningful impact of the European Information Infrastructure will affect Small and Medium Enterprises (SMEs), which are penalised because they cannot afford to make large investments in the development of private intelligent networks and services. To counter this, the competitiveness of European SMEs can be relaunched through the creation of the European Information Infrastructure, offering services from EDI to videomail and diffused database accesses.

5. New Services and Applications

The evolution of new services and applications continues to be "effervescent", mostly due to multimedia and functional integration. The technologies required are already available, and in some cases have been for years now, but only recently have the widespread availability of PCs, more intelligent networks and the reduction in costs opened the market to a large set of very pervasive new applications and services for improving not only productivity but also the quality of the life.

5.1. Groupware

The "Groupware" concept was introduced in the 1960s by people such as Engelbart, Holt and Flores, who also produced the first product for the market, the famous "Coordinator".

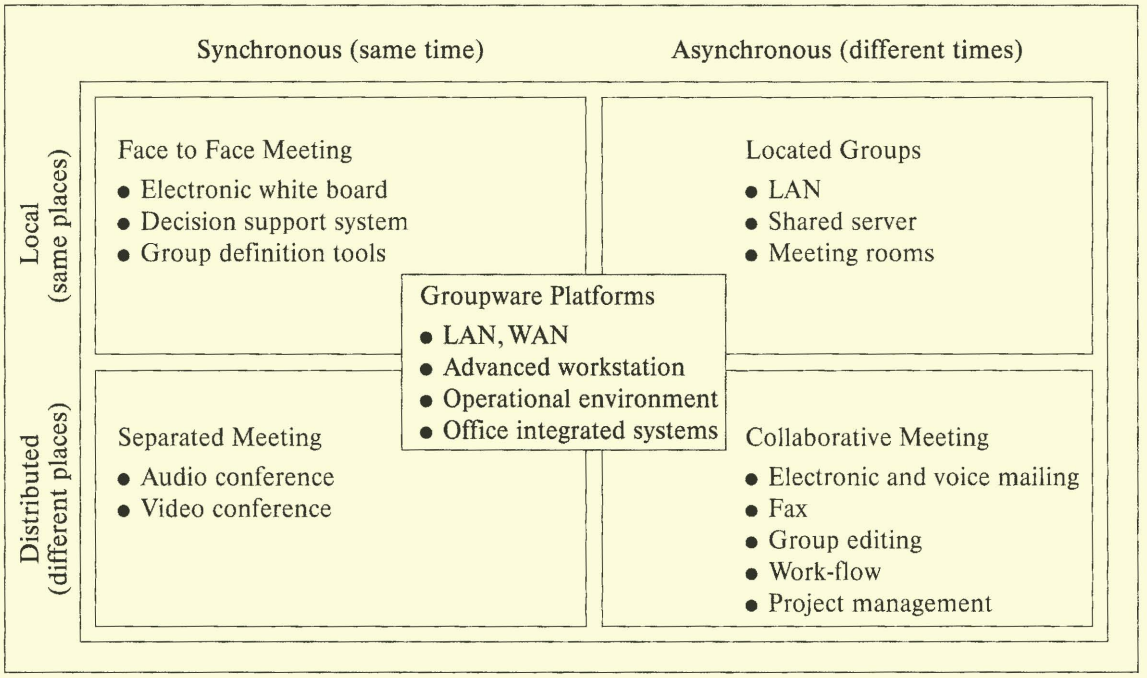
The term "groupware" is often used with different meanings corresponding to the different possible approaches and solutions:

i. groupware as the technology that allows use of a set of available office automation facilities: practically a marketing solution for selling already existing systems with a new concept;

ii. groupware as a set of systems that support the activities of a team of people working together;

iii. groupware as an "innovative" technology that allows a team of people to work and operate efficaciously.

Figure 25
Groupware Options



Source : SMAU

The last two approaches highlight the central issue of *cooperative* work and of collaborative computing, and therefore, all the aspects and problems of a powerful team organisation. Most of the research and implementation groups, including the Institute for the Future of Menlo Park in California, consider groupware as in ii. or iii. and with the possible time/space options depicted in *Figure 25*. The tools and platforms can be the same for all the different options: advanced and, if possible, multimedia workstations, LAN, electronic Whiteboard, WAN support (in particular ISDN), office automation, integrated tools and services, and so on.

The key elements of groupware are office communication tools, coordination tools and cooperation tools.

Groupware helps people to work better together. A collaborative system creates an environment in which people can share information without the constrains of time and space.

Network groupware applications link work groups and the group in a common, on-line venue for meetings, and it lets members work on the same data simultaneously.

Collaborative applications include calendar management, video teleconferencing, computer teleconferencing, integrated team support and support for business meetings and group authoring. Messaging and E-mail systems represent the most basic type of groupware.

There are certain fundamental aspects of collaborative systems: common task, shared environment and time/space. The first measures the extent to which the members of a work group can work on the same task. A strong shared-environment system keeps each member informed of what a project's condition is, what the level of coparticipation is, and so on. Time/space collaborative systems focus on the time and place of the interaction, as shown in *Figure 25*. Another approach to real-time teleconferencing places a single-user application in a computer-teleconferencing environment. Information is exchanged among multiple users using a protocol that determines who has the floor at any given time. One key tool is the electronic Whiteboard, which can also be "shared" in a distributed context.

GDSSs (Group Decision Support Systems) are a groupware "specialisation" and provide tools for decision structuring, idea generation, voting and ranking. GDSSs have different feature levels. Level 1 emphasises the improvement of communication, idea formation and discussion, and message processing. Tools for Level 1 include messaging, screen viewing, rating/ranking scales, agendas and voting.

Level 2 systems incorporate the strenghts of decisionsupport modelling and group-decision techniques to enhance the system. Examples of these techniques include project planning and control/operations research tools such as CPM (critical Path Method) and PERT; probability and decision techniques that are designed to solve complex, unstructured problems and to help to coordinate information exchange in a-synchronous problem-solving groups.

Level 3 systems, which are in the development stage, automate group communications patterns.

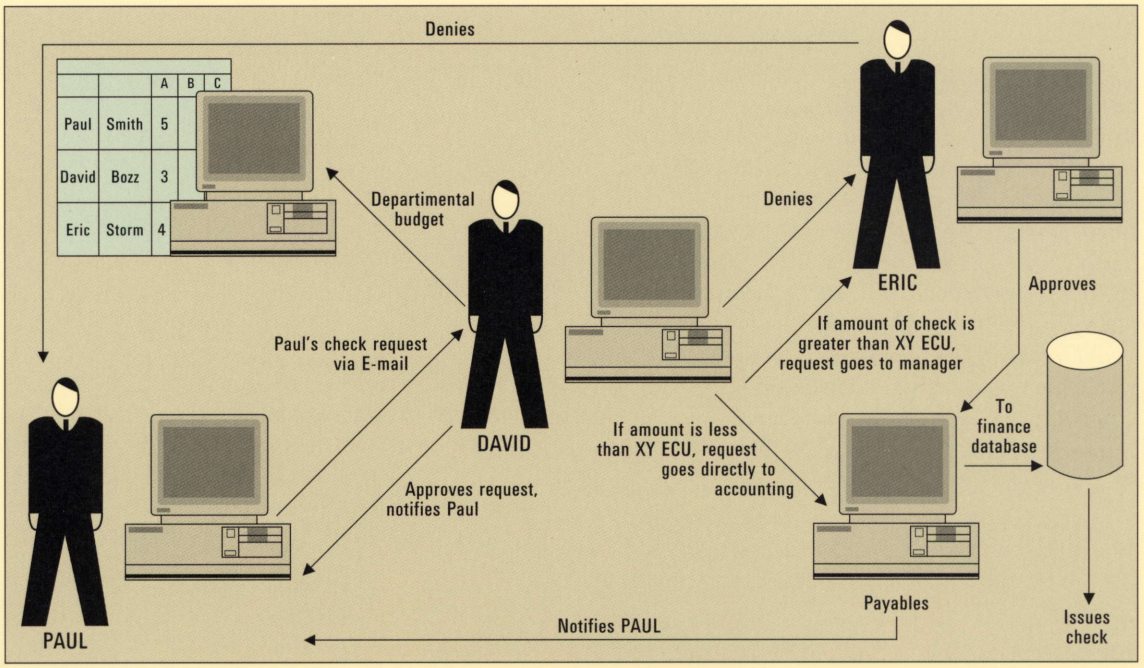
5.2. Work Flow

Among the many potential applications for E-mail, the one that has sparked the most interest is work-flow automation. Work flow is a subset of groupware. Work-flow packages digitally replicate existing business processes that involve routing paper or forms among employees. Work flow makes work more decision-related and less paper-related. An example of work flow, shown in *Figure 26*, is processing travel expense report. Other basic work-flow applications include purchase-order and invoice processing, vacation and leave requests, creation of sales proposals, engineering change orders and editorial production flows.

Experts identify three basic architectures for work-flow systems. The first type is user or client-based and allows individuals to automate their interactions with other people and applications. The second type of work-flow system is object or agent-based. Forms carry the intelligence that each client needs to process the form correctly. Each form has active fields that can invoke specific actions, such as calling an external database. The form design decides which fields are active or even visible to each user. Both user and agent-based systems usually use E-mail services. The last type of work-flow system is server-based: the server is the single logical centre which normally supports the database. A single centre allows an easier view and control of a work flow.

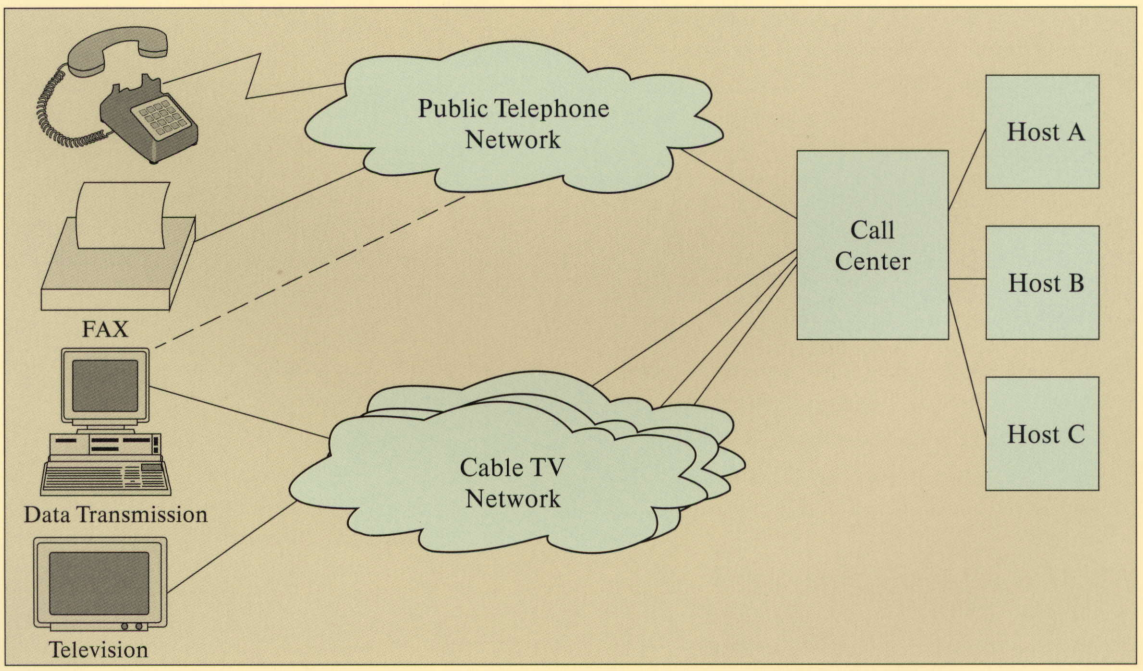
The work-flow evolution will follow "multimedia" evolution and will be driven by growing end-user needs.

Figure 26
Expense-Report
Work Flow



Source : SMAU

Figure 27
Audiotex
Service Scheme



Source : SMAU

5.3. Audiotex

The Audiotex services, also known as Premium Rate Services, allow "vocal" access to a lot of information provided by computers without the need for live operators. In other terms, it is possible to have access to a "database" from the "traditional" telephone device, using the voice directly or the telephone keypad or both: answers can be provided by voice, using pre-recorded sentences, or by fax, or by electronic mail.

The following different players can be distinguished in an Audiotex service:

- *the end-user* who, by means of telephone set, calls a specific telephone number in order to obtain some information or to do something, such as booking tickets, ordering goods, carrying out financial transactions or taking part in conferencing groups, in TV games, etc;
- *the information provider,* who owns, produces and manages the information required;
- *the service provider,* who owns and manages the computerised devices necessary for handling the above information;
- *the network provider,* who rents the basic telephone service.

The information and services providers operate as "value-added" providers on the telephone lines, and the Audiotex user, the caller, is normally charged directly by the network provider with a higher rate on his telephone bill.

The typical scheme of an Audiotex service is shown in *Figure 27,* which outlines:

- the public telephone network;
- the "call centre", an intelligent PABX with automatic call distributor and voice-response unit;
- the host computer, dealing with the required information;
- other networks for delivering the information (for example, cable TV, data transmission, etc).

From the technological point of view, there is no specific news, but clear "multimedia" integration. Meaningful improvements to these types of services are derived from:

- the introduction of digital telephone networks;
- the introduction of intelligent networks;
- speech synthesis and recognition;
- OLTP, On-Line Transaction Processing;
- interoperability among different networks and different protocol piles.

The main characteristic of the Audiotex services is the actual interactivity. All the "vocal information" is recorded in files on RAM. The user is able to establish a real "conversation" with the system, following information and menu-driven trees.

Different techniques can be used for this interactivity, depending on the type of telephone set:

i. "grunt detection", that is, recognition of silence/noise: no sound/any sound is pratically the "binary" information the user can deliver by means of a simple telephone, and the system can recognise and understand;

ii. with a multifrequency telephone (DTMF, Dual Tone Modulation Frequency), each telephone key is used, recognising the proper meaning that depends on the context;

iii. voice recognition is the ultimate technique, but its use and diffusion are at present limited to few words.

The main appeal of the Audiotex is its potential diffusion: every telephone user can access these services. This mass aspect is also used for televoting and mass calls, for instance, during TV performances, quizzes, and so on.

5.4. Virtual Reality

With the "hype" term "virtual reality", we refer to a "computer-simulated world" where the "user" can interactively operate with three senses.

The first applications of "virtual worlds" arose in the 1960s in space and atomic-centre simulators, for pilot and operator training.

The development of computer-based simulators has been improving in sophistication, in particular with the explosion of graphic screens and interfaces; and computer-based simulations are now used in several different fields, from aeronautics to space, from chemical plants to atomic laboratories, and so on.

The parallel evolution of videogames, more and more interactive, and the evolution of multimedia now allow the user to "enter" the virtual world and to see, hear and touch all of its components.

Two different approaches to virtual reality have been followed by developers:

- the "unencumbering" approach, where the I/O devices are the "traditional" keyboard, stick, camera, microphone, loudspeaker, screen;
- the "encumbering" approach, which requires ad hoc devices, such as electronic glove, three-dimensional glasses, electronic helmet, overalls, and which allows "human" interface to the system and assures global perception and interaction.

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Part Two

The European Software and Services Market

This paper has been provided by International Data Corporation IDC in close cooperation with the EITO Task Force. For further statistics see also Part Three "Statistical Outlook".

1. Software and Services Market Trends

The European Software and Services marketplace was worth 69.3 billion ECUs in 1993. It reported a 5.3% performance. This is however a noticeable decrease as compared to the 1980s, which can be explained by several factors.

Firstly, the overall economic situation had a definite impact on the market. While some countries, such as the United Kingdom and Scandinavia, were already experiencing a recession in 1991, other traditionally dynamic markets, especially Germany, France, Italy and Spain, reported a sharp economic downturn in 1992. While investments started decreasing, the psychological impact of the recession became noticeable and an increasing number of users postponed and redimensioned their IT investments. Low hardware shipments (in the mainframe and medium-scale markets, more particularly), had a negative impact on specific market segments, such as system level software, for example.

Also, it is true that the European market has now reached a high level of qualitative maturity. Traditional types of professional services like software development services, for example, have been under considerable price pressure. This situation is jeopardising the stability of many independent vendors who are very dependent on this type of service.

1.1. Software Products

The software products segment represented 28.8% of the European Software and Services market in 1993, with 20 billion ECUs in value, a 7% growth as compared to 1992. The trends characterising the market are specific to the three main segments of the market: system level software, application development tools, and application solutions (the category "systems software" in the following tables and figures refers to system level software and application development tools combined).

System level software

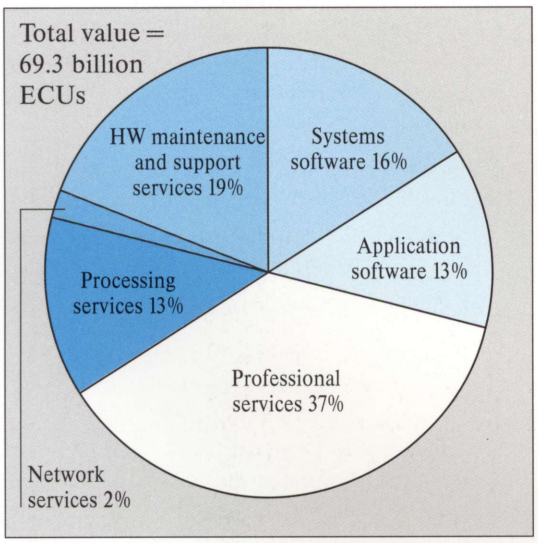
The European system level software market was worth 6 billion ECUs in 1993. The strategic importance of system level software has tended to increase for a variety of reasons.

Users are increasingly requiring more flexible and cost-efficient DP systems, their demand tends to shift towards products providing more efficient control over the management of their DP resources and more optimised use of their hardware power. Consequently, the demand for advanced operations management software is increasing. In addition, the most important technological directions of the IT market (client/server and distributed computing, open systems, networking) have a direct impact on the demand for network and server operating systems.

Table 1
European Software and Services Market by Product Category

	Million ECUs					Annual growth rates (%)			
	1991	1992	1993	1994	1995	1992	1993	1994	1995
Systems software	9,929	10,623	11,262	11,928	12,721	7.0	6.0	5.9	6.6
Application software	7,250	8,050	8,723	9,487	10,380	11.0	8.4	8.8	9.4
Software products	**17,180**	**18,674**	**19,985**	**21,415**	**23,101**	**8.7**	**7.0**	**7.2**	**7.9**
Professional services	22,523	24,171	25,766	27,413	28,881	7.3	6.6	6.4	5.4
Processing services	8,187	8,535	8,860	9,157	9,441	4.3	3.8	3.4	3.1
Network services	1,273	1,450	1,643	1,844	2,083	14.0	13.3	12.2	13.0
Hardware maintenance & support services	12,772	13,005	13,089	13,213	13,460	1.8	0.6	0.9	1.9
Services	**44,755**	**47,162**	**49,359**	**51,626**	**53,866**	**5.4**	**4.7**	**4.6**	**4.3**
Total SW and services market	**61,934**	**65,836**	**69,344**	**73,041**	**76,967**	**6.3**	**5.3**	**5.3**	**5.4**

Figure 1
European Software and Services Market by Product, 1993. Billion ECUs



A range of key market trends have to be identified:

- The slowdown in shipments of mainframe and proprietary systems is impacting the market. In addition, the price competition across small and medium-scale platforms drives margins downwards.
- Interoperability is becoming a crucial user requirement. The industry has long funded its development on a centralised computing and mainframe-dominated marketplace with production management and storage management standing out as key demand directions. This situation is becoming less and less true. The shift of computing power towards smaller and more decentralised platforms under the effect of the downsizing trend is revolutionising the marketplace. The mainframe marketplace being what it is, many third-party vendors are hesitating over which strategy to pursue.

Data centre products are also increasingly required to support an enterprise focus. Enterprise focus can take two forms: increased platform coverage for existing products or products

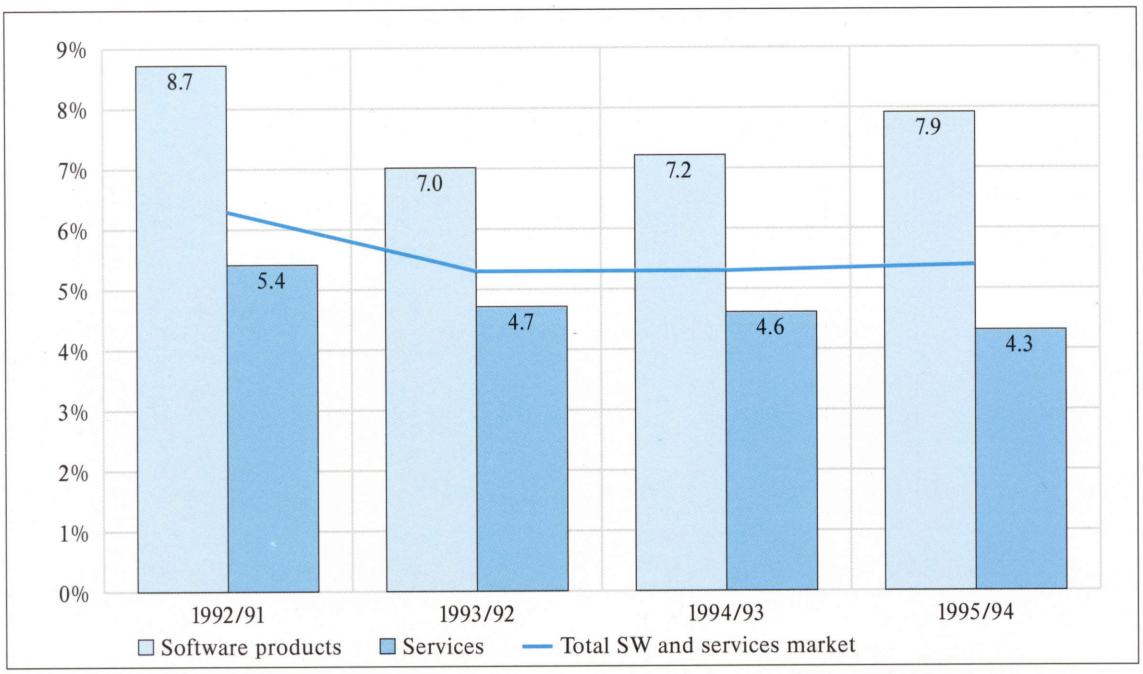


Figure 2
European Software and Services Market. Actual Growth and Forecast

that provide new functional capabilities. Most leading vendors are moving to embrace this enterprise approach.

- The hardware panorama is changing. The market is still dominated by IBM 370 and PCM systems and as such it is impacted by the recessionary climate of the large-scale systems marketplace. There is also a clear pressure on the price of software largely explained by a high level of saturation. Competition is becoming fiercer as a large number of large-sized vendors conflict in a shrinking marketplace. Replacement strategies will expand with vendors tending to compete on their competitors user base by providing more advanced products.
- Distributed computing is taking on increasing importance in the market as competitive products are emerging. Unix is emerging as a common standard for public procurements corresponding more closely to the "architectural" DP approach of European users.

Application development tools

The European application tools market has emerged over the past few years as a key market segment. The explosion of the PC market together with the downsizing trend have boosted the demand for more productive application development tools (4GL, GUI-based and Windows-based tools) and for distributed database management systems. The emergence of new software technologies and environments (Unix, NT, etc.) facilitates and decreases the cost of portability and of reusability. More integrated tools are efficiently addressing the needs of users confronted with high intensity complex distributed applications.

Figure 3
European Software Products Market. Actual Growth and Forecast

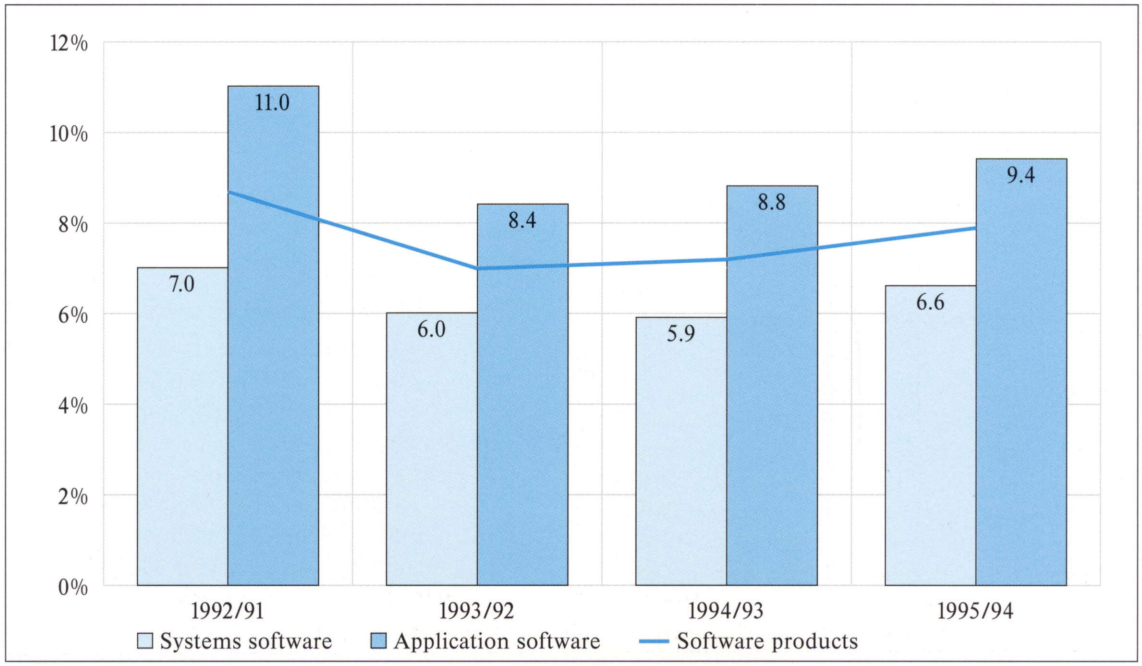


Table 2
European Software Products Market by Segment. 1991-1995

Million ECUs	1991	1992	1993	1994	1995
Systems software	9,929	10,623	11,262	11,928	12,721
Application software	7,250	8,050	8,723	9,487	10,380
Software products	**17,180**	**18,674**	**19,985**	**21,415**	**23,101**
% breakdown					
Systems software	57.8	56.9	56.4	55.7	55.1
Application software	42.2	43.1	43.6	44.3	44.9
Software products	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Two key marketing issues: time-to-market and pressure on prices

- The time-to-market criterion has emerged as a critical element for successful strategies. One key example is the speed at which most DBMS (Database Management Systems) vendors have been accelerating the porting of their supply under Unix. Another example is the flourishing number of Windows-based CASE products.

In this connection, the trend will amplify with the introduction of new operating systems and from top management's drive for strategic advantage from enterprise integration. Vendors with flexible product architectures will meet with increasing success.

- The pressure on prices will become ever more important as users will not tolerate the widening gap between ever lower priced platforms and stable software licenses. The pressure on

prices will be exacerbated by an increasing competition when products approach functional adequacy and widespread market penetration.

In addition, the marketing cycle of software tools will tend to become more complex as the decision process becomes lengthened by the complexity of organisational changes required for redesigned business processes.

Distributed computing and platform portability as leading technological directions

- From a technological point of view, the trend towards distributed computing is counterbalancing the continued decline in the mainframe and proprietary minicomputer worlds. Customers are selecting distributed software tools and solutions for ease-of-use. Winning products are those which increase the user's decision capacity.

  In this connection, Unix, PC LANs and the small-scale systems are emerging as platforms of choice for downsizing. Consequently, GUI interfaces for widely used report generators are experiencing high growth rates.
- Tools enabling a "low-cost road to information access" are becoming more visible in the market. SQL gateways to corporate data from spreadsheet vendors and PC data access and browse tools are gaining in popularity. All these depend on the middleware necessary to bridge networks and DBMSs as well as to define the data views. The key to realising the data access dream will be middleware products.
- The 4GLs market is being shaped by cross-platform portability and scalability requirements. These products will draw benefit from the development of distributed applications as users will see the scalability and maintainability advantages of these products.

The 4GLs market will experience less intense price pressure from low-end application development products targeted for networked PCs. Differentiators will continue to be the automated generation of integrity, transaction, and screen navigation code available from high-end products. Also the portability and DBMS access features will continue to differentiate 4GLs and maintain price differentials.

Database Management Systems: major trends

- On the database market, traditionally seen as a leading segment of the tools market, products are becoming ever more complex in terms of functionalities. Vendors are now gearing up to support more complex distributed architectures. The client/server trend will amplify and will be dominated by graphical clients for single-server DBMS applications with processes to communicate between applications. In this respect, the strategic role of middleware development tools will tend to increase.

The market is also characterised by an increasing commoditisation of multi-user DBMS products. Vendors are gradually running out of differentiating features. High-end and midrange multi-user DBMSs have established parity on features that 80% of their users demand. Although multi-user DBMSs are not yet commodities like personal DBMSs, the trend is inexorable. In time, multi-user high-end and midrange DBMSs vendors will all align.

Consequently, prices are expected to evolve downwards. This pressure will be exacerbated by the movement to downsized systems and by the strategy of vendors with roots in small-scale systems. Vendors will be gradually forced to diversify along geographic and niche functional dimensions. They will also tend and enhance their services offering.

Value-added products and services will be the two core guidelines of this market. Vendors will

focus on supporting customers in their implementation process. Products will incorporate more sophisticated CASE and 4GL features, they will also provide more efficient distributed application management features. DBMS vendors will also pursue value-added resellers of applications based on their engines.

Object-orientation and CASE: strengths and weaknesses of two new technologies

- Object-orientation will also become a key strategic direction for the 4GLs market. Objects will enhance the 4GL competitive positioning relative to CASE vendors to the extent that they increase the intuitive nature of the user metaphor. 4GL vendors are aiming to make their tools as easy to use as point solutions. Objects will also enhance code reuse and the facility with which code is ported to other environments.

However, in spite of this increasing endorsement of object-orientation by users (exemplified by the success of C++, for instance), the market is still in its infancy and is characterised by a very large number of software developers. Users still have to learn object-oriented application development methods. Vendor strategy will shift from selling shrink-wrapped C++ languages to the provision of complete team development environments with optional class libraries.

- After a few years of hesitant emergence, the European CASE market has become a reality.

CASE tools are increasingly used for the development of client/server architecture-based applications and the penetration of CASE tools will increase significantly especially among medium-sized accounts. However, the market will also experience a tough price war as it develops on the lower-end (PCs, low-end workstations) and as more vendors compete for market share.

The potential of the European market is extremely important. The penetration of CASE tools in user installations is still very low (less than one site out of three is equipped). Vendors have ample opportunities for recruiting more sites, especially among medium-sized companies. In this respect, the next five years are going to be a crucial period as the market share factor will, in the long run, be decisive for dominance.

The data processing community will become more price conscious as a consequence of falling hardware prices. Central data processing departments, the de facto contact for selling CASE, will be pressured towards cost reduction. This trend will be particularly noticeable among large users. Unit prices will be under pressure from low-end tools. These tools are born in the PC market, and therefore have a low unit price. Their scope of function is increasing allowing an unpleasant comparison with high price "real" CASE tools.

Consequently, more CASE vendors will be forced to move into the low-end of the market. With present two-digit growth rates, all central DP sites will have a CASE tool installed at the end of the five year period. This will lead to some form of market saturation which vendors will try to avoid by addressing the low-end of the market.

The function of CASE inside user organisations is also evolving. While CASE has primarily been used for front-end design purposes (i.e., data design, problem analysis, requirement specifications), users are now using CASE at more critical stages of the application development cycle. CASE is now more commonly used in later stages, such as implementation design, testing, and code generation.

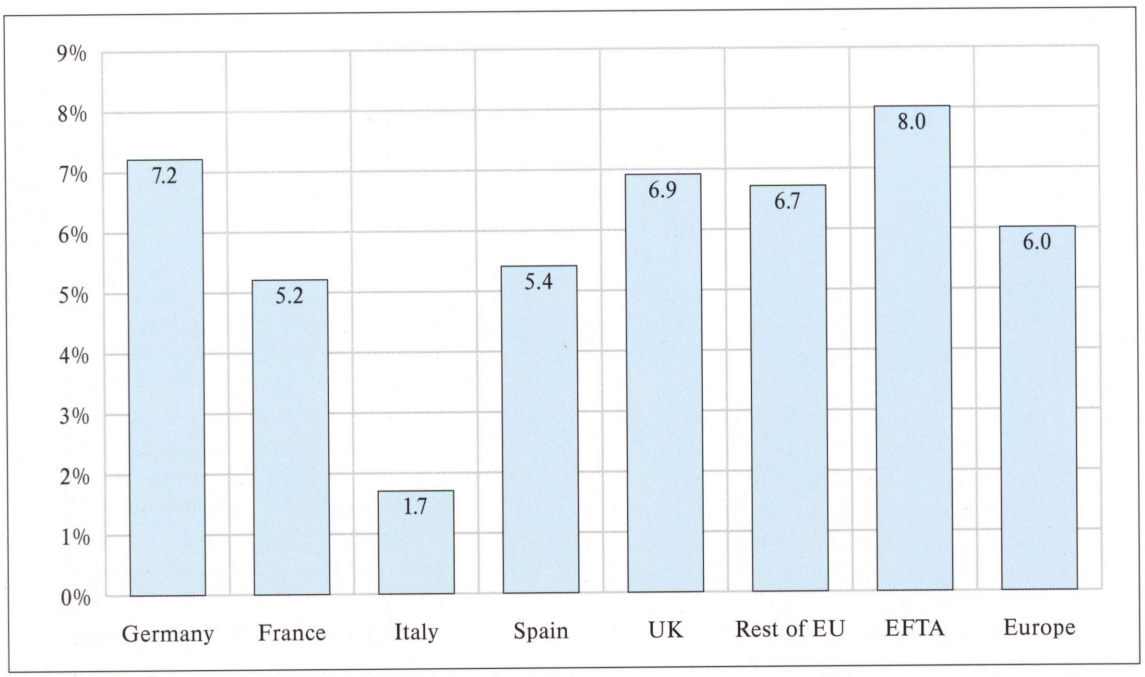


Figure 4
European Systems Software Market, 1993
% Annual Growth by Country

Application solutions

Historically dominated by mainframe or medium-scale systems-based customised software. The solutions market has been evolving towards increased standardisation jeopardising the market positions of many professional services companies. The trend towards distributed computing is opening new horizons as up-sizing users are contending with new applications requirements and as down-sizing accounts have to manage the transition towards open systems-based solutions.

Downsizing has an increasing influence on the solutions marketplace

- The migration from mainframe-based centralised IT systems towards client/server-based architectures is often accompanied by the shift from customised solutions towards standard software. Although it is true that the majority of companies are not prepared to

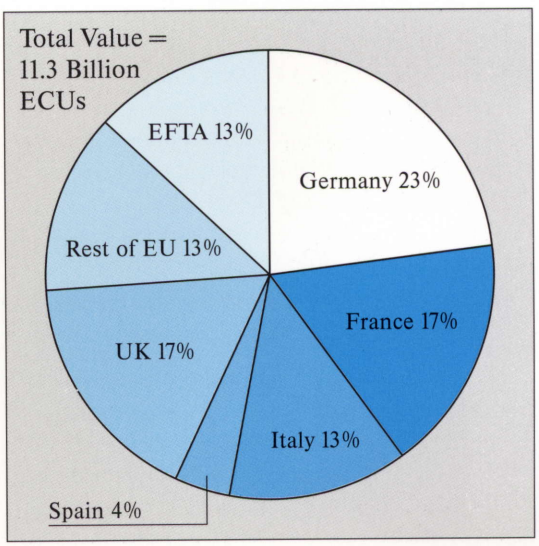


Figure 5
European Systems Software Market by Country, 1993

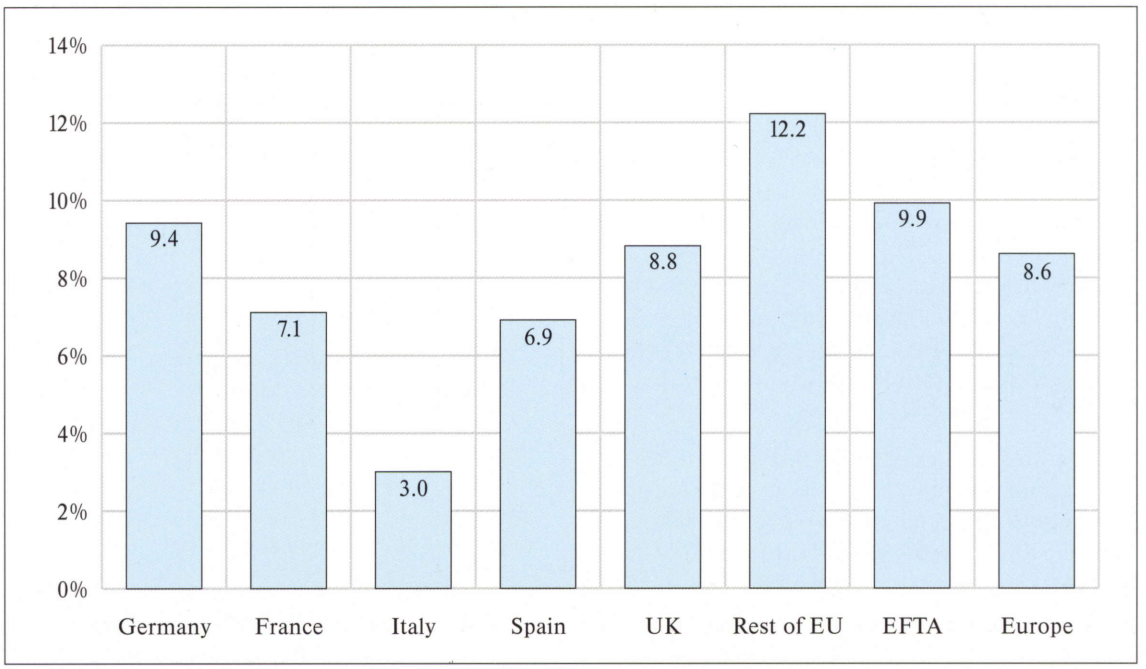


Figure 6
European Application Software Market, 1993. % Annual Growth by Country

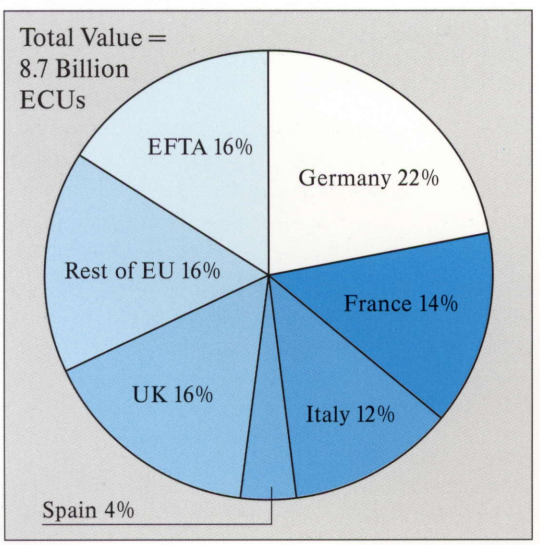


Figure 7
European Application Software Market by Country, 1993

abandon legacy applications, new sales are coming from smaller distributed platforms. Vendors of applications such as accounting, human resource, and finance are beginning to deliver more distributed solutions on Unix platforms.

The European market also reports a high level of saturation on traditional segments (accounting, payroll, etc.). This has lead to a rapidly concentrating software industry in some segments. CAD/CAM is an example. The limited market potential (price and need constraints) of mainframe-based applications has led to market exhaustion. Consequently, the industry at the high-end is becoming more concentrated.

New types of applications, more in line with corporate priorities, are now taking the lead. The market for Human Resource Management applications is a good example. User organisations are increasingly becoming aware of the importance

of maximising their in-house resources as a key strategic tool, and as a way to attract and keep quality personnel.

Platform and technical integration will be key market directions

- Open systems, and particularly Unix, are having an important impact. The low-end segment of the Unix market is benefiting from low-priced, easy-to-use products, especially at smaller sites. In the manufacturing software segment, for example, most de facto, single-user, system-based standard products are being ported to Unix.

A noticeable growth of Unix system-based applications will be found amongst sites using Unix - both for commercial and technical applications - while the market for pure technical Unix users already appears to be saturated.

- The trend towards technological integration is intensifying. New features can be seen as a competitive advantage at a time of market saturation. A good example is accounting software which now integrates more analysis tools and functions. The use of accounting information is advancing beyond routine reporting of static information to more ad hoc, custom reporting, often used for strategic decision making and planning. Hence, desktop analysis tools that can access mainframe data in a seamless environment have become very attractive. Most leading accounting software vendors provide common spreadsheet formats for the transfer of financial data.

End-users will be increasingly looking for solutions helping them to leverage on the value of information.

- Professional support tools will represent a key market. They consist of software products designed to help end users access and report information. This includes: spreadsheet/business modelling, end-user data access/EIS, and statistics/technical data analysis.

This category will be assuming an increasing importance on the software market as a growing emphasis is put on data warehouses and on automating knowledge workers across organisations.

Executive Information Systems, for example, will meet with increasing success. These emerged in the mid-80s as a way to give executives direct access to information related to corporate-level decision making. The market focus is now shifting toward the information access needs of knowledge workers in general.

End-user data analysis tools will present a substantial opportunity for software vendors. The transformation of data into usable information requires analysis tools. For many, the traditional spreadsheet will continue to suffice. Others will require more complex tools such as multidimensional or statistical analysis tools.

Additionally, information packaging and distribution requirements will stimulate demand for reporting functionality, whether it be within a spreadsheet or in a specialised reporting tool. New features, such as more flexible formatting and integration with E-Mail or other groupware products, will encourage even current users to consider upgrades or displacements of older products.

Despite the popularity of end-user data analysis tools, in particular the spreadsheet, ad-hoc electronic access to data has been limited. Even in finance departments, financial data is commonly re-keyed into a spreadsheet for analysis and reporting. Although still common, this practice is rapidly losing acceptance, particularly as new data access products and features become available.

A view by vertical market

The attitude of users as far as packaged software is concerned is quite variable between vertical sectors. Local regulations, the availability of local language-based applications, the operating environment panorama (Unix vs. proprietary systems), DP budget constraints, are all factors that call for country-specific situations.

Generally speaking the demand for packaged solutions is resistent: around 40% of users from all countries agree that they expect their investments in packaged software to remain the same (except for the United Kingdom where this figure is down to 28%) and 35% to 40% say that they expect it to increase (except from the United Kingdom where this figure is actually 61%). The degree of involvement of specific sectors varies from one country to another: manufacturing and services-related sectors (retail, education, government, business services) appear as particularly dynamic in most countries with "increase" percentages above average.

1.2. Professional Services

The professional services segment represented 37.2% of the European Software and Services market in 1993, with 25.8 billion ECUs in value, a 6.6% growth as compared to 1992.

IT Consulting

IT Consulting is seen as an ever more strategic service

Consulting is the second largest segment. The market is spurred by the needs for Business Process Redesign consisting of the methodical restructuring of business processes and management systems within an organisation; it is aimed at adapting the information systems (by the integration of new technologies, and the dismantling of time-worn processes) to a new level of business performance.

IT Consulting has become increasingly more important in the user organisations that need to know how MIS departments and information systems can efficiently dovetail business trends and strategic options. Services vendors are consequently integrating the management structures of users more and more as they become direct counsellors on the adaptation of IT systems to the needs of the enterprise. Consequently, IT Consulting services still enjoy comparatively higher margins as the level of professionalism and vertical expertise is relatively high.

The IT Consulting market is rather concentrated with a dominating presence of large-sized US-based groups. The strategic importance of large-sized PS and Systems Integration contracts makes it ever more necessary for vendors to be able to supply consulting services as a basic component. European companies facing the competition of multi-talented US-based companies are, therefore, extremely eager to acquire these skills through acquisitions, often risking a high level of brain-drain as the level of turnover of IT consulting staff is high, following the development models of US-based vendors.

While on average only 20% to 30% of European users in all major European countries are reporting no expected use of IT consulting services, there are some significant sector-specific differences between countries. For instance, in Germany, the leading sectors are the discrete manufacturing, the retail and the government sectors which are showing the way (with over 30% of users expecting some use of IT consulting services). On the other hand, leading sectors in France are the banking, the insurance, the health care, the wholesale and the government sectors.

	Million of ECUs					% breakdown				
	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
Professional services	22,523	24,171	25,766	27,413	28,881	50.3	51.3	52.2	53.1	53.6
Processing services	8,187	8,535	8,860	9,157	9,441	18.3	18.1	17.9	17.7	17.5
Network services	1,273	1,450	1,643	1,844	2,083	2.8	3.1	3.3	3.6	3.9
Hardware maintenance & support services	12,772	13,005	13,089	13,213	13,460	28.5	27.6	26.5	25.6	25.0
Services	**44,755**	**47,162**	**49,359**	**51,626**	**53,866**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 3
European Services Market by Segment, 1991-1995

Meanwhile, custom software is facing tough market challenges

Custom programming represents the largest share of the European Professional Services marketplace. The European industry is still extremely fragmented as the level of required primary human resources and financial investments is low. In countries like Germany, for example, the industry is composed of a large number of smaller developers often dependent on a restricted number of clients. The industry is expected to increasingly concentrate as users will identify packaged solutions as more cost-saving DP budget allocations and as they will become more independent with more user-friendly and powerful programming tools.

Another important threat to the custom software development services industry will be the pressure on prices. Fixed costs development contracts, better suited for mastering DP expenditures, tend to be preferred to traditional cost and fee staff delegation contracts. This imposes a different economic environment to services vendors who face the necessity of more-efficient cost models and project evaluation methods. Consequently the custom-software market is set for a period of significantly lower performances.

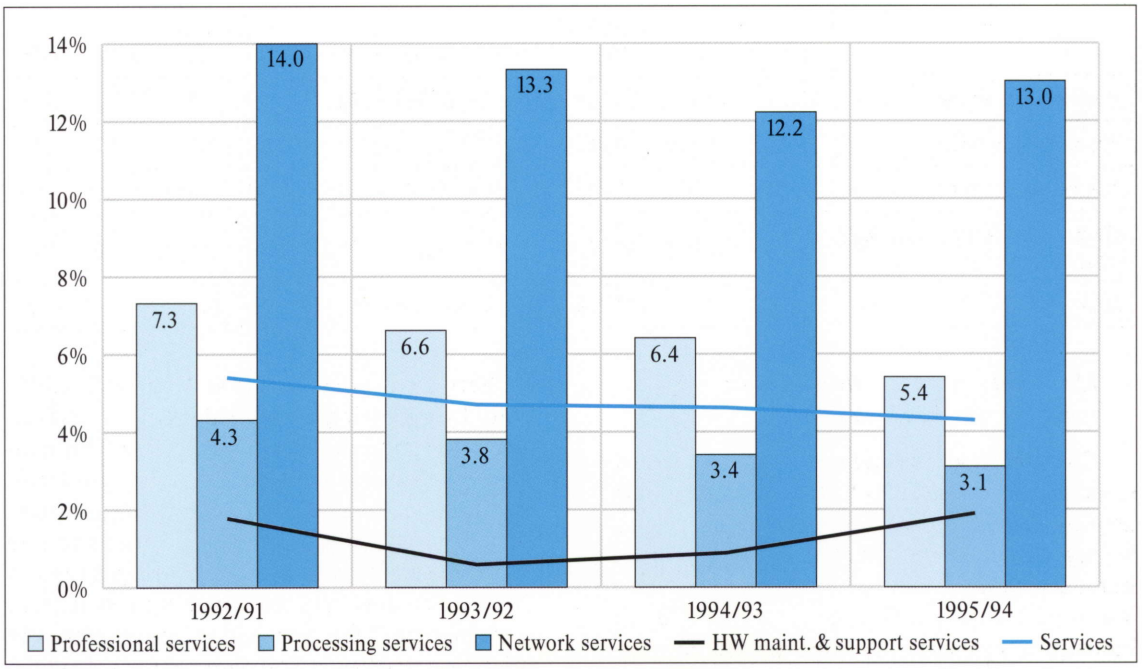
Services vendors will try and bypass this difficulty by supplying higher value-added services like application maintenance services. This market represents a considerable opportunity as users are becoming more and more conscious of the value of their portfolio of applications and are confronted with numerous technological issues (Open Systems, Networking, etc.) that spur their demand for application revamping and migration. Packaged Software vendors also tend to rapidly develop their supply of services as packaged software kernels are associated with customisation services.

Sub-system implementation services

Sub-system implementation services consist of all services involved when physically integrating and implementing systems into the organisation. Cabling Services are a major component of this segment.

Large-sized projects are gradually multiplying in the market with the outcome of Intelligent Buildings for example. At the same time, mergers between vendors are spurring the needs for network reorganisation and integration projects. The development of this market will allow the emergence of a category of small-sized network integrators with talented and trained staff, but with no capacity in application software development.

Figure 8
European Services Market. Actual Growth and Forecast



Facilities management and outsourcing

Facilities Management and Outsourcing are among the fastest growing segment among all professional services, but they also represent a risky market.

The competitive environment of all individual geographic European markets is now in a state of transition. FM vendors are flourishing. Hardware vendors are targeting the market very aggressively as they try to secure their account control.

Although major consolidation operations have already been reported. The reorganisation pace of the FM market will be significantly slower than for most other services segments.

The importance of the relationship between supplier and customer, regarded as a key feature of an FM contract, will complicate the process of acquisition required to produce the necessary degree of shake out. The number of vendors will increase as more hardware manufacturers are pushed to enter the market as a defensive measure in order to retain a sufficient level of account control.

The development of the market is very uneven. The UK represents by far the most mature market both in terms of size and in terms of maturity of users. It should keep its leading position as the public administration opens up to the FM alternative. The French market is rapidly evolving and the FM services industry is reorganising at an accelerated pace. The German market is still one generation behind and is suffering from the relatively conservative attitude of large-sized user groups.

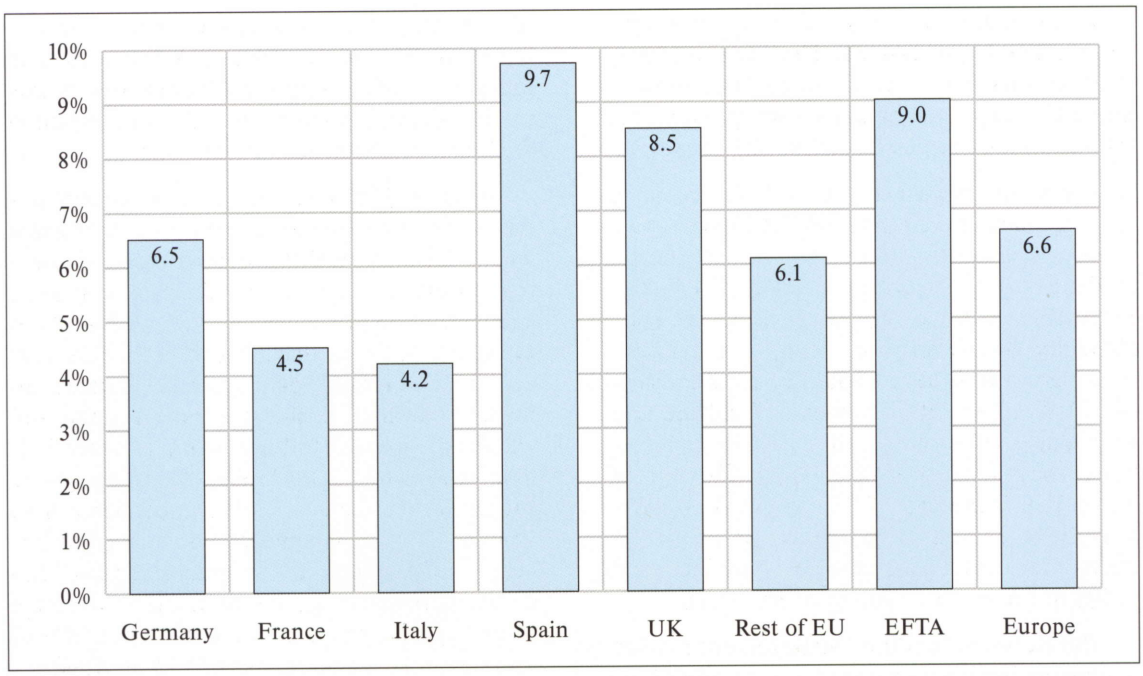


Figure 9
European Professional Services Market, 1993. % Annual Growth Rate by Country

The impressive performances of the market in terms of growth can be explained by several trends. Globally speaking the trend towards outsourcing benefits a lot from the technological transitions experienced by users. For many user organisations managing older centralised systems while developing and putting into place new architectures is not an easy task: the lack of inhouse skilled and experienced resources, the necessity of migrating old applications onto distributed architectures, etc. are all factors explaining the use of external qualified services. Users will tend to increasingly delegate the management of their ever more complex communication environments. The technological capacity of services vendors will represent an increasingly important selection criterion for user corporations in need of more effective DP cost-control methods.

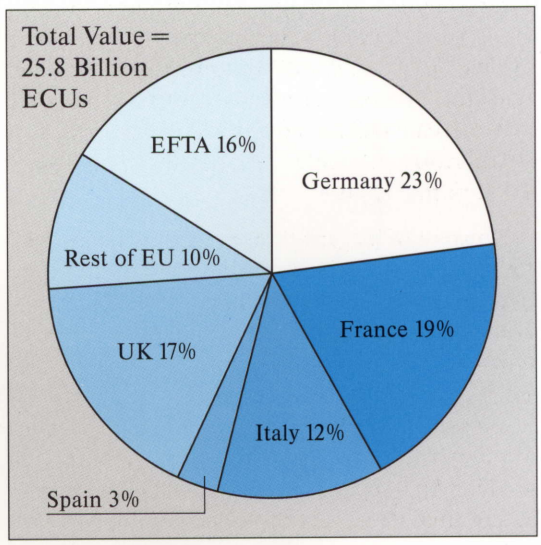


Figure 10
European Professional Services Market by Country, 1993

As the market develops it will also become more and more professional. The financial stability of vendors as well as their ability to communicate efficiently and regularly with their clients will represent a key competitive advantage.

Transition Management will represent a growing share of the European FM marketplace. Users will be contending with multiplying IT challenges as they migrate towards distributed computing architectures and open systems. Managing this transition will be a task increasingly entrusted to a qualified external partner. More users with a low-end IT culture and knowledge will move to client/server architectures (especially users from the desktop world using the Windows NT "channel"). Consequently, more and more vendors will position themselves on the market using their technical ability to manage technological transitions.

The Network Facilities Management market is showing important signs of growth and of reorganisation. A few major vendors (supported by niche providers in geographical markets) will survive. This trend will be driven by a number of factors like global internetworking, national network capabilities, strong service and support organisation, flexible service alternatives, or network management strategies.

In spite of its growth prospects, the FM marketplace includes some strategic risks. Many vendors have based their strategy on the provision of cheap processing power capacities, however users are gradually acquiring cheaper and more powerful systems (workstations, distributed platforms...) which are gradually reducing the cost-advantage of processing-oriented FM services. In addition, many vendors are exacerbating this trend as they often do not hesitate to lower more than necessary the price of their processing services in order to develop their contracts portfolio and to foster their sales of higher margins services (for example, consulting). Consequently, for many vendors who have invested heavily to position themselves on this market, the risk in seeing the value of computing facilities decline in the future is high.

In spite of its potential, the FM concept still has to convince European users. A major IT users survey has shown that the percentage of European users not considering the outsourcing of data centre operations is still very high (80% in Germany, 87.5% in Italy, 78% in France), except for the UK ("only" 54%). Services-related industries, such as business involved, retail and wholesale, are relatively speaking the most FM-involved sectors. In the United-Kingdom, where the market is comparatively more mature than anywhere else in Europe, four sectors (Government, education, process manufacturing, discrete manufacturing) are particularly dynamic in this respect (with between 10% and 20% of users expecting a heavy use of FM services).

IT training

Users will put a growing emphasis on the IT training of their staff

The shortage of qualified personnel and a high level of staff turnover motivate a high level of demand. The training services industry in Europe is extremely fragmented: systems vendors are among the largest providers as they control the hardware and often the software technology, (more specifically in the case of System Level Software). Independent vendors are nevertheless becoming ever more conscious of the potential in the market as well as its logical interaction with IT and Management Consulting projects. Moreover, users, once extremely loyal to systems manufacturers on this aspect, are gradually seeing Independent Services Vendors

(ISV's) as an alternative: the advent of Open Systems is accelerating this trend, as there is no reason to be linked to a specific vendor.

Training appears as a rather unreliable type of service: in difficult economic times users are price-sensitive and tend to easily postpone or even cancel education courses. The supply is evolving towards more "customised" types of courses seen as less expensive and more efficient. Parallel to this, courses tend to become technically specialised more and more to address issues such as networking, heterogeneous problems, even though the bulk of the market is still made up of basic technical courses such as programming, languages, systems, applications. More advanced issues such as client/server computing and CASE, though still representing an extremely minor share of the market, will become ever more important.

One other major characteristic of the training services marketplace is the specificity of demand of each sector. Depending on the country, the intensity of the demand for education and training services is very variable from one vertical market to another. For example, in Germany the insurance and the health care markets are the most dynamic markets (with over 40% of users expecting some heavy use of training and education services). On the other hand, the Italian market reports lower rates on average with the retail sector holding a leading position (39% of users expecting some heavy use of training and education services). France reports the highest rates for the Government, the health care and the manufacturing sectors (from 30% to 40% of users expecting some heavy use of training and education services).

1.3. Country Specific Focus

Germany

The performance of the market in 1993 (5.2% growth) has been severely altered by the depressed economic climate. Nevertheless, a range of factors like the strong and steady demand in the Eastern part of the country, or the rapid migration towards client/server (especially among mid-sized enterprises), etc. have helped Germany rank among the leading European markets in terms of growth.

A major direction for the German market is the move towards open systems, and particularly towards Unix. The demand for Unix-based packaged solutions is resistant, especially on commercial accounts. The demand for Unix-based solutions, especially in the manufacturing and in the banking/financial markets, is strong. The application tools segment, especially DBMS, is also expanding at a particularly high rate.

The demand of German user organisations has traditionally been very much oriented towards customised solutions. Confidentiality and security reasons, as well as cultural factors, were the main reasons. The large number of medium-sized user organisations in the German economy represents a potential of new and under-prospected accounts. Moreover, the supply on the market is rapidly maturing as tool vendors try to complement their offer with solutions and leverage on custom-software-equipped accounts. In addition, the demand for German companies for extending their area of operations to the Eastern part of the country will have a beneficial effect on the market.

However, in-depth changes in the attitude of users and in their acceptance of the out-sourcing alternative are being noticed. Traditionally rather conservative as far as the control over IT systems is concerned, German users are evolving rapidly.

Figure 11
German Software and Services Market. Actual Growth and Forecast

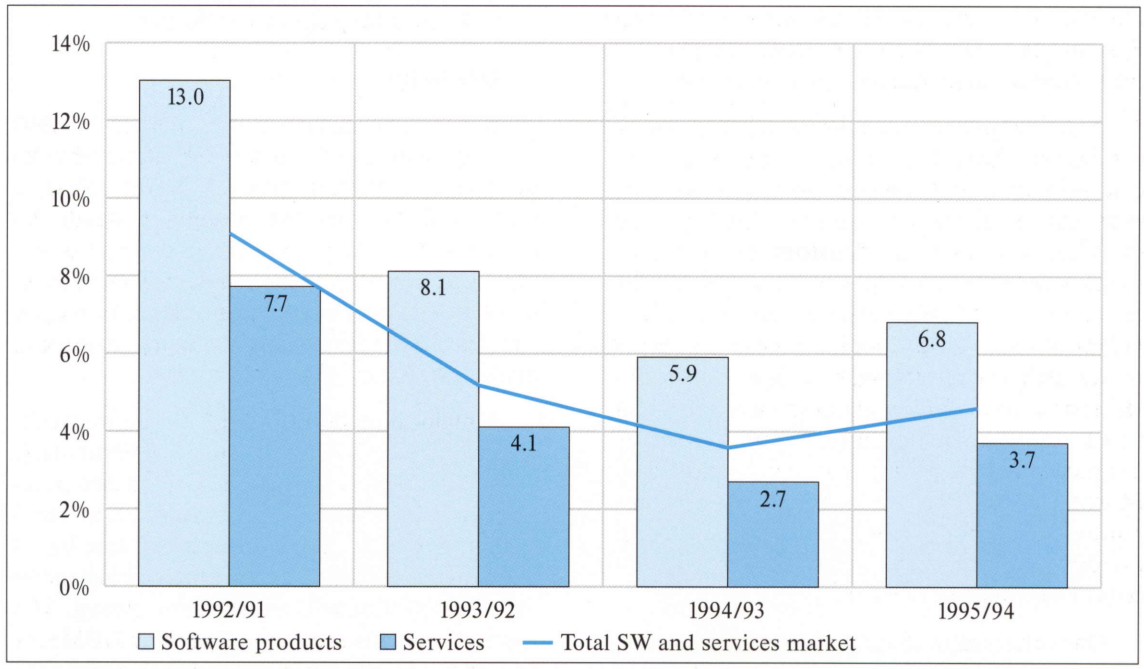


Table 4
German Software and Services Marketplace by Product. 1991-1995

Million ECUs	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Systems software	2,102	2,349	2,517	2,646	2,800	9.4	5.5
Application software	1,574	1,806	1,975	2,114	2,282	12.0	7.5
Software products	**3,676**	**4,154**	**4,492**	**4,759**	**5,082**	**10.5**	**6.4**
Professional services	5,010	5,561	5,922	6,219	6,560	8.7	5.3
Processing services	1,928	2,027	2,113	2,164	2,239	4.7	2.9
Network services	152	178	205	231	263	16.2	13.4
Hardware maintenance & support services	3,340	3,462	3,445	3,386	3,386	1.6	- 0.9
Services	**10,429**	**11,228**	**11,685**	**12,000**	**12,449**	**5.8**	**3.2**
Total SW and services market	**14,105**	**15,383**	**16,177**	**16,760**	**17,531**	**7.1**	**6.4**

A new generation of managers, more DP-educated, is gradually gaining more influence in the structure of the economy. These new managers are less DP-sensitive than the older generation and easily reconcile confidentiality necessities with outsourcing requirements. The fear of losing power over the hardware base is no longer as acute as it used to be, and managers tend to put more emphasis on the strategic value of the information rather than on the strategic value of the infrastructure.

France

The performances of the market have been dampened by the persistent recession in 1993. Industrial investments stalled and internal demand slowed down. Nevertheless, the software products segment managed to report a fairly high growth rate (6.0%) as compared to other segments of the Software and Services marketplace.

As in most other European countries, the outsourcing concept is gaining ground. DP budget constraints will increase and outsourcing strategies will be more often selected with a positive effect on the demand for packaged solution.

As the level of competition on the French software and services market is increasing, the stability of prices is ever more put into question. The pressure on prices, especially on the PC software side (for products like spreadsheets and word processors) has become harmful for many vendors as these compete for market share. Vendors will certainly strive to reduce the margins left to distributors to compensate for this trend. PC-based packaged software will tend to be increasingly seen as a commodity and distribution channels will adapt rapidly with the rapid growth of software superstores.

United Kingdom

The UK market is, in terms of maturity of demand, one of the most advanced markets in Europe. It was worth 11.2 billion ECUs in 1993, growing by 6.2%. The local management culture enables an easier penetration of standardised US-based products. Also, the UK software industry, and particularly an important group of medium-sized ISVs, has managed to supply genuine locally-developed products meeting user requirements very closely.

In addition, the outsourcing concept is also far more accepted than in any other European country. The structure of the FM industry reflects this level of maturity. Most US-based vendors have started their European expansion from the UK market. There is also a large number of local mid-sized FM vendors with a considerable importance.

The proportion of large-sized contracts is higher in the UK than anywhere else in Europe. Large-sized institutions, in sectors as DP-sensitive as public administration and banking, easily contemplate the use of outsourcing solutions. More than in any other country, the recession has accelerated the development of the FM marketplace.

The penetration of FM in central government remains comparatively low. However, the government has shown signs of increasing the emphasis placed on the importance of FM within individual departments. The principal evidence of this assertion is the outsourcing of the major proportion of the Inland Revenue's computing requirements. The strategy of the UK public administration will have extremely important consequences on the FM market not only because of the size of contracts but also the size of the contracts will mean that co-operation strategies will have to be put into place between services providers as none of them has the necessary size to fulfil all the required tasks. At the same time, the State will certainly want to multiply its sources of services supply.

Figure 12
French Software and Services Market. Actual Growth and Forecast

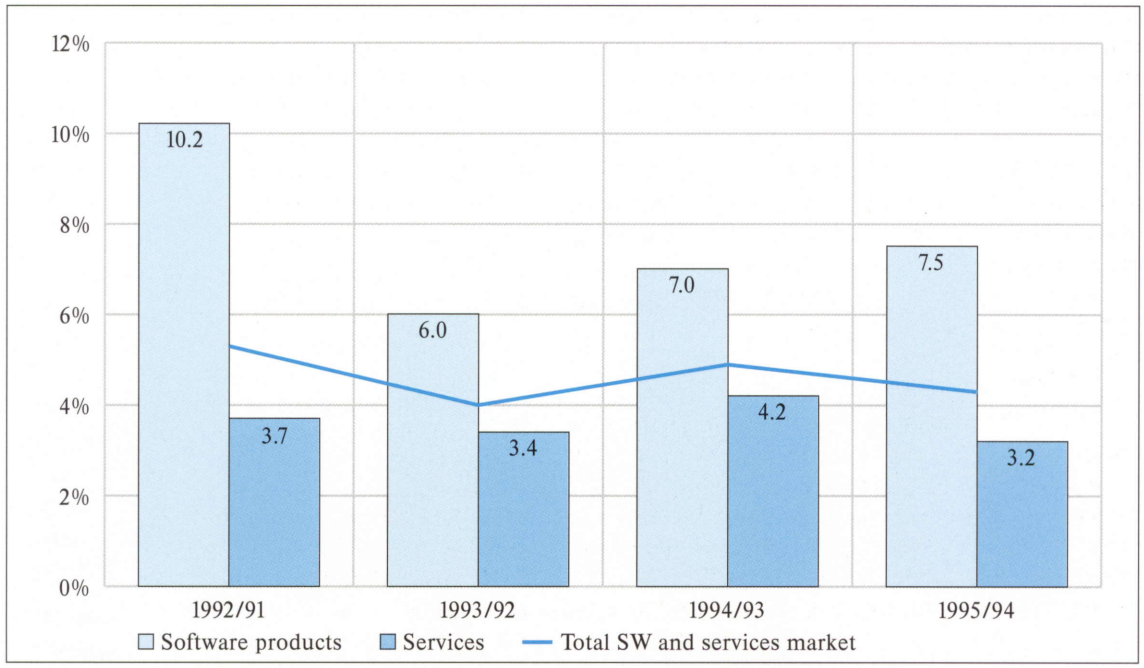


Table 5
French Software and Services Marketplace by Product. 1991-1995

Million ECUs	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Systems software	1,684	1,820	1,915	2,031	2,165	6.6	6.3
Application software	1,054	1,198	1,284	1,391	1,514	10.4	8.6
Software products	**2,738**	**3,018**	**3,198**	**3,422**	**3,679**	**8.1**	**7.3**
Professional services	4,444	4,743	4,958	5,232	5,405	5.6	4.4
Processing services	1,414	1,471	1,519	1,551	1,579	3.6	1.9
Network services	181	203	235	283	340	13.9	20.2
Hardware maintenance & support services	2,709	2,655	2,668	2,708	2,760	- 0.8	1.7
Services	**8,749**	**9,072**	**9,380**	**9,773**	**10,083**	**3.5**	**3.7**
Total SW and services	**11,486**	**12,090**	**12,579**	**13,195**	**13,762**	**3.7**	**4.6**

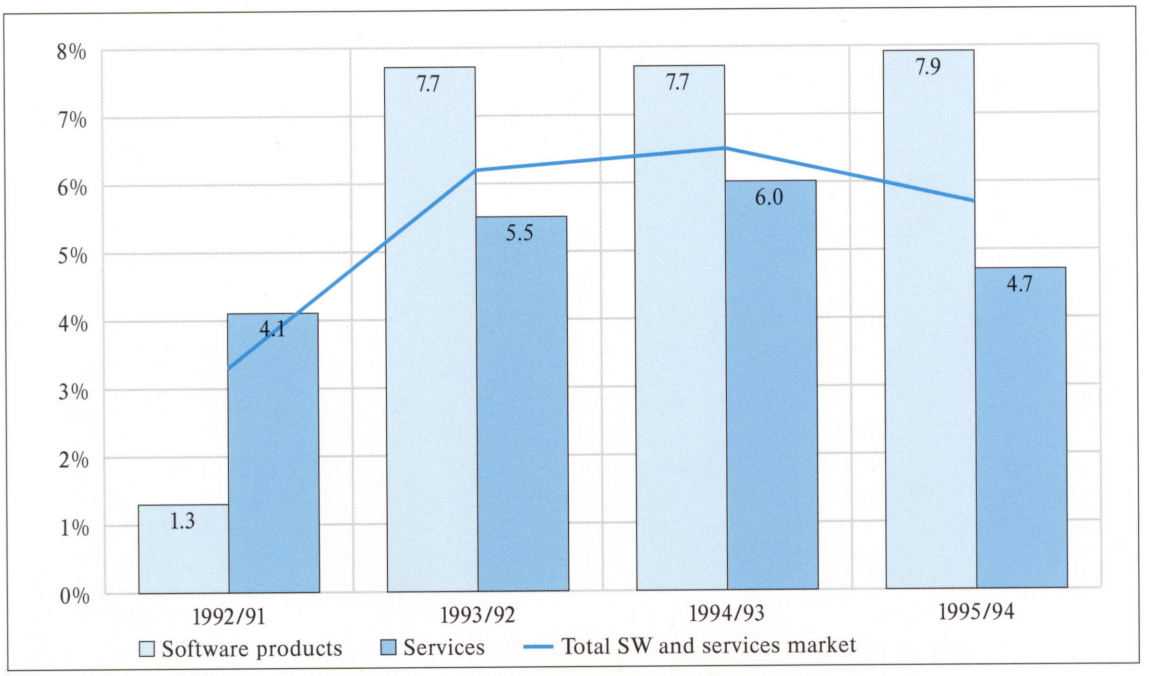


Figure 13
UK Software and Services Market. Actual Growth and Forecast

Million ECUs	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Systems software	1,794	1,772	1,894	2,023	2,163	2.8	6.9
Application software	1,235	1,297	1,411	1,537	1,679	6.9	9.1
Software products	**3,029**	**3,069**	**3,305**	**3,561**	**3,842**	**4.5**	**7.8**
Professional services	3,801	3,995	4,336	4,711	4,978	6.8	7.1
Processing services	1,053	1,086	1,110	1,133	1,146	2.6	1.6
Network services	200	249	295	336	380	21.4	13.6
Hardware maintenance & support services	2,118	2,135	2,138	2,171	2,241	0.5	2.4
Services	**7,172**	**7,465**	**7,879**	**8,351**	**8,745**	**4.8**	**5.4**
Total SW and services market	**10,201**	**10,534**	**11,184**	**11,912**	**12,587**	**2.9**	**3.7**

Table 6
UK Software and Services Marketplace by Product. 1991-1995

Figure 14
Italian Software and Services Market. Actual Growth and Forecast

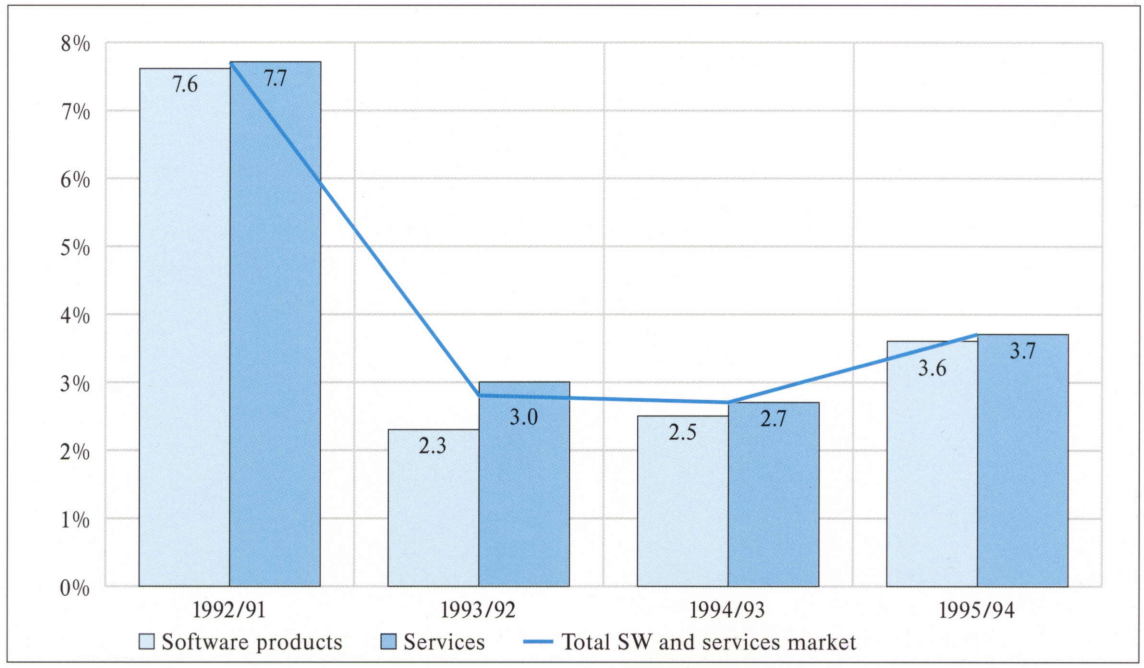


Table 7
Italian Software and Services Marketplace by Product. 1991-1995

Million ECUs	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Systems software	1,385	1,468	1,494	1,512	1,540	3.9	1.5
Application software	921	1,013	1,043	1,087	1,154	6.4	5.2
Software products	**2,306**	**2,481**	**2,537**	**2,600**	**2,694**	**4.9**	**3.0**
Professional services	2,778	3,075	3,203	3,306	3,455	7.4	3.9
Processing services	730	762	755	762	773	1.7	1.2
Network services	300	337	369	400	437	10.8	8.8
Hardware maintenance & support services	1,141	1,156	1,166	1,175	1,185	1.1	0.8
Services	**4,949**	**5,330**	**5,492**	**5,643**	**5,850**	**5.3**	**3.2**
Total SW and services market	**7,255**	**7,811**	**8,030**	**8,243**	**8,544**	**4.5**	**4.9**

Italy

The Italian software and services market was worth 8.0 billion ECUs in 1993, after recording a very low 2.8% rate of growth. The structure of the Italian software and services industry is characterised by a large number of small to medium-sized companies, servicing a number of clients on a local basis. These often have limited resources to address larger markets and to sustain sufficient research and development efforts to cope with technological trends. Few Italian software houses are covering the whole country market or have yet put into place an international strategy.

However, this structure is showing signs of intense evolution. The Public Administration, for example, is redefining its role and influence in the shape of the Italian software and services industry. The attitude of the Italian public administration is changing rapidly, taking into account the European deregulation trend. The Italian State is giving an increasing importance to IT management issues (returns on IT investments, cost efficiency, etc.). On the side of local public administration, local authorities are striving to develop their "services to the citizen" providing better tax and economic management capacities.

Also, a large number of Italian software houses are modernising their management style. More vertical market-oriented structures are being adopted. Most mid and large-sized companies have understood that they could not compete on all markets and have decided to focus on specific vertical segments. Flexible matrix-based structures are commonly adopted enabling the provision of standard practices on a specific number of markets. Vendors are gradually putting into place partnership relations in order to solve profitability and under-capitalisation problems.

Although the outsourcing alternative is still relatively little used, some specific vertical markets have a remarkably strong potential. The public administration, for example, is currently focusing on an intensive modernisation phase in areas such as fiscal administration and police, and requires more efficient software. This represents an opportunity for national providers who are able to match technologies with a new generation of packages, as well as for large-sized players.

Spain

The market reported clearly lower performances (7.0% growth in 1993 compared to 9.3% in 1992) and has been impacted by a rapidly decelerating economy and by an austerity economic policy.

Many local companies felt directly the impact of a tougher business environment. The Spanish IT market is integrating in the European Union at a very rapid pace posing major strategic challenges to local software and services vendors. Foreign companies have taken major strides, opening offices and subsidiaries and acquiring Spanish vendors. German, French and US-based companies have been particularly acquisitive. Vendors positioned in the public sector had a particularly difficult year given the drastic cuts in public spending.

Spanish public authorities have decided to re-organise their assets and to capitalise on their technological potential. Public participations are being re-organised and re-structured. This trend will amplify in the future as the Spanish public authorities strive to clear out State-owned assets.

Another particularly dynamic market is the financial sector. The structure of the banking market is changing quickly with major mergers between financial institutions. This has major consequences on the pattern of the IT demand in specific domains like systems integration and outsourcing.

Figure 15
Spanish Software and Services Market. Actual Growth and Forecast

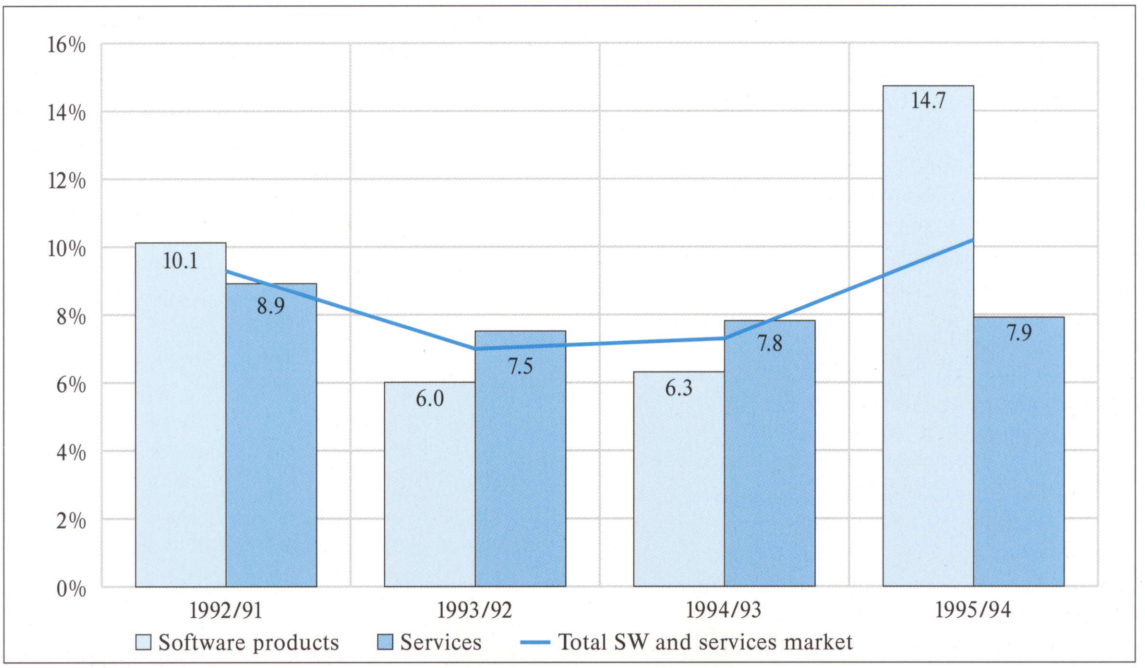


Table 8
Spanish Software and Services Marketplace by Product. 1991-1995

Million ECUs	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Systems software	438	471	497	526	596	6.5	9.6
Application software	295	336	359	383	447	10.3	11.6
Software products	**733**	**807**	**855**	**909**	**1,043**	**8.0**	**10.4**
Professional services	650	724	794	884	987	10.6	11.5
Processing services	151	158	164	170	176	4.2	3.7
Network services	23	27	31	35	39	15.5	11.8
Hardware maintenance & support services	601	643	679	710	738	6.3	4.3
Services	**1,425**	**1,552**	**1,668**	**1,799**	**1,940**	**8.2**	**7.8**
Total SW and services market	**2,158**	**2,359**	**2,524**	**2,708**	**2,984**	**1.1**	**5.5**

2. Evolution in the Competitive Environment

The competitive environment on the European market will experience in-depth evolutions until the end of the decade. The opening of trade barriers as well as the increasing thrust of foreign vendors, mainly US-based, will represent critical strategic challenges and will push European vendors to concentrate and gain in critical size.

The competitive environment on the European market is already showing signs of rapid change. The European software and services marketplace is characterised by a high level of industry fragmentation: for example, the top ten companies have a 15% market share only, the top 300 companies 44%. However, the market is steadily concentrating: the top fifteen vendors controlled 13% of the market in 1988. This figure reached 17% in 1992.

New strategies will correspond to a renewed economic environment

The European market is becoming more integrated into the world software and services marketplace. The pressure on software and services prices is one major trend affecting the market.

Falling software prices are becoming the story of the 1990s. As the software market increasingly "industrialises", especially on the desktop side, the average cost of packaged software is set to steadily decrease in volume since the ultimate marginal cost of a software product is basically the cost of replication.

This trend will be emphasized during the decade. The limit to which prices can decrease is certainly very low. This is going to have important consequences on the strategies of software developers. Among others there will be an increasing separation of market roles between companies producing software, and those marketing it. Few companies will be able to afford an in-house approach and control everything from production to distribution.

Off-shore programming is emerging as a software alternative

In order to adapt to these new requirements, both users and software vendors are striving to leverage on cheaper labour sources. Off-shore programming is becoming a more commonly found practice. Large-sized user corporations are becoming increasingly aware of the competitive advantage they can draw from their international structures by drawing benefits from the existence of consulting and programming resources based in their foreign subsidiaries. The reverse situation is also becoming true as foreign-based companies tend to appeal to cheaper or more specialised resources from their home country.

Off-shore programming services can take several forms ranging from the placement of temporary staff to off-site and on-line development via satellite or terrestrial communication facilities. Quite a number of US-based vendors have started developing their facilities in cheap labour countries.

In Europe, this trend is facilitated by the gradual dismantling of trade barriers enabling an easier flow of services across borders. Even though the off-shore programming marketplace is still in its infancy in many respects, it will become rapidly a creditable alternative as Pan-European data exchange networks arise and facilitate off-site services and as user organisations increasingly integrate internationally. However, although there is clearly a future for an off-shore programming market, one should not underestimate the fact that possible lay-offs in DP shops could pull programmer prices down and consequently reduce the competitive advantage of cheaper off-shore programming labour.

Countries with high programming process find an increasing interest in this type of business. In Scandinavia, more specifically, off-shore programming is showing strong growth signs. The Baltic countries as well as some neighbouring East European countries are becoming homes for off-shore companies.

The European software products industry will increasingly economically integrate

- The European market is characterised by the high level of fragmentation, especially on the software solutions side. This can be explained by the existence of country specific social regulations which have traditionally hampered the development of an integrated supply.

The software industry is composed of many small vendors with a low level of non-local sales. The introduction of common European regulations, as well as the necessity for more international user organisations to manage their resources on a multi-country basis, will certainly provide an opportunity for a more internationalised market. However, this process will be very slow.

While hardware vendors and US editors increase their market shares

- Systems manufacturers and US-based ISVs are holding key market positions. These two categories of vendors will compete ever more aggressively to defend their market shares.

Users will put an increasing strategic emphasis on the acquisition of systems level software and consequently higher management layers on the organisations' side will tend to be more associated in the decision making process. The winning strategies will be those focusing on the provision of products embodying power and ease of use. Vendors will also develop more extensible software protecting customer's software investment and therefore account control.

Professional services prices will also be increasingly affected by the level of competition

The level of competition on the professional services market is increasing as the number and types of competitors develops. Hardware manufacturers are eager to expand their activities in a domain which they see as very profitable in terms of value-added. Telecommunication carriers are now also taking marketshares in specific areas like Network Outsourcing and systems integration.

The boundaries between traditional IT-related services and management consulting activities are also gradually fading away opening the door to management consultancies. These companies are providing a link between information technology issues and general management problems. These companies have understood that business process re-design needs represented a major opportunity to position themselves on the IT market.

Systems integration is a factor that helps the market concentrate

From a technological point of view, the market is bound to concentrate. The older growth model dating from the 1950s until the 1970s and dominated by the supply of processing services and software development services, allowed a large number of vendors to cohabit. The barrier to integration represented by proprietary and incompatible architectures, and by captive and protected markets, as well as the low level of start-up investments needed, enabled a large number of vendors survive with limited level of free and real competition.

As more investment-intensive supplies of services appeared, the market started industrialising. The emergence of packaged software as an alternative to custom services, exacerbated this trend. The number of possible vendors started

shrinking since controlling larger market shares became necessary to survive and because vendors were limited by their capacity to invest.

The future is set for an increasing concentration. Vendors are definitely looking for the most productive software investments. On the services side, systems integration is a very investment intensive marketplace: the management of high-risk contracts, the necessity of providing services on a consistent international scale, etc. are naturally limiting the number of possible actors.

- The rapid growth of the systems integration market is pushing software and services vendors to enhance their partnership strategies as well as their attitude towards the subcontracting issue. More and more, vendors are starting to team up to bid for large-sized integration contracts in order both to spread the technological and financial risks among several companies and also to leverage on differentiated skills and specialisations. In this respect, alliances and collaborations can be vague and variable but are a necessary strategic element.

Packaged solutions vendors, for instance, are actively facing this issue. The development of services capacity is key not only because systems integration is a channel of distribution for software products but also because more flexible package offerings require a high degree of customisation.

The Community will have a key role in easing the integration process

- New competitive rules are also emerging in the wake of the deregulation trend. The action of European authorities for the opening of public markets is combining itself with the new strategic directions of central and local governments looking for alternative services supply. However, it is true that this deregulation process is still unevenly developed.

3. The Market of Hardware Maintenance and Support Services

- The traditional services industry is quickly becoming a commodity market. The bottom line for user organisations purchasing a multivendor service agreement is price. With so many providers battling for the limited revenues available for service, it is not surprising that users can afford to be particular about selecting a service provider and negotiating for the types of services that meet their company's needs.

Users are increasingly driving the IT industry's evolution and are demanding a more proactive approach to adopting new technologies. The business goal of user organisations is to make the most of their information technology investment. Ultimately, business wants to use IT to gain a competitive market advantage.

The demand of users is evolving as IT systems are becoming more complex ...

- In this context, the hardware maintenance services market has gained in strategic importance as technology manufacturers and service providers are confronted with users' difficulties in adopting and integrating new and existing information technologies. As customers' environments are increasing in complexity, so does the nature of traditional post system-implementation services. These now commonly include support activities such as installation and start-up, remote support (e.g., diagnostics, bulletin boards, help desks, bug fix and software delivery, and documentation services), parts repair, and on-site maintenance (e.g., on-site break fix, moves and changes, preventive and predictive maintenance, and trouble shooting).

Hardware maintenance services are also at the confluence of fundamental requirements. Among others, user corporations are also looking for cheaper ways to perform services that were once performed internally.

... and remaining competitive requires new business strategies

- Maintenance services are becoming more and more assimilated by users as a commodity, the price of which has to be as low as possible. This pressure on prices is exacerbated by an intense competition between technology manufacturers and services providers.

In order to adapt to this competitive style, most vendors in this market have to constantly diversify, expand, and enhance their portfolio of support offerings. Strategies consisting of maintaining and managing systems in a more cost-efficient manner (e.g. predicting and preventing problems, fine-tuning systems) are no longer sufficient. Many of these services do not always represent a strategic advantage to user enterprises. Users are requiring more value-added services: re-engineering, customer training, vertical market focus, etc.

- The direction that traditional services providers must take to be competitive in today's market diverges greatly from that of technology manufacturers. Technology manufacturers tend towards research and development in order to be contenders in the global marketplace. They are somewhat removed from contact with the end users. Their primary focus is on building the best products and selling them to almost anyone in the world.

Different business models have emerged among technology manufacturers to address vertical market needs and the relationship of post-integration to consulting and implementation initiatives. Business models of the leading technology manufacturers illustrate that there are a number of different strategies to achieve a similar result.

- Business strategies will strongly evolve. The core parameter to remain competitive will be to address many of the same issues user organisations are struggling with: how to reduce the costs of doing business while simultaneously providing quality services and products.

Hardware manufacturers and services providers will look at ways to automate and rationalise their maintenance operations, they will try to make an increased use of their resources. New partnership and collaboration directions will emerge as vendors tend to concentrate on technological or vertical areas and to ally with third-party vendors for other areas.

4. User Directions

European users have started experiencing the technological and market evolutions discussed above. As they face DP budget constraints and as they have to make increasingly committing DP choices (in terms of distributed computing standards, of software development technologies, etc.), user organisations are modifying their strategy.

- As the price war becomes more intensive on the software products market, internal development departments are more and more competing against independent software providers. In a major users survey in the four main European countries (Germany, France, United Kingdom, Italy) it was found that around 44% of users expected an increase in their investment in packaged software as compared to only 9% expecting a decrease. The highest rate was found in the UK with over 60% of users surveyed reporting an expected increase in investments in packaged software.

This confirms the clear trend among users in choosing the most cost-effective solutions in their software decision-making process. At the same time, the clear benefit that packaged applications can draw from the crisis is exacerbated by the shift from mainframe-based and centralised DP systems towards client-server architectures and open systems. As users increasingly contend with distributed computing issues, they start realising the critical added-value as well as the cost-benefit which they can draw out from the supply of portable packaged applications.

- In contrast, it seems that, although impacted by the price war, professional services are not drawing such as clear a benefit as packaged software is.

The attitude of users as far as their demand for services is concerned has to be analysed in relation to their demand for packaged software. The percentage of users expecting an increase in their demand for services, though still high (36%), is consistently lower than for standard software. On the contrary, there are more users expecting a stabilisation of their demand for Professional services (53% as opposed to 45% for packaged software). Once again, the UK stands out as the market where the outsourcing concept is most strongly accepted.

- However, traditional services, such as hardware support services, are acquiring a key position in users' demand. Organisations are trying to make most of their existing hardware base in spite of the availability of cheaper and more powerful hardware resources. The increasing complexity of hardware environments (distributed computing, networks, etc.) motivates important needs in hardware management support on the users side. Confirming this, the already mentioned users survey has shown that over 43% of interviewed users expected their demand for hardware maintenance services to be "heavy" in 1993; the highest rate was reported in Italy (49%). Only 11% of users anticipated a "light" use of hardware maintenance services.
- Nevertheless, the outside delegation of responsibility over traditional internal MIS functions seems to have some limits. The outsourcing of the management and of the control over (part of) the IT is still a marginal phenomenon in terms of market value. For example, in 1993 the European Facilities Management market is worth 1.9 billion ECUs, that is to say only 7.5% of the total professional services marketplace. 75% of interviewed IT users said they did not anticipate any use of data centre outsourcing services and only 4% reported an expected "heavy" use of outsourcing services. These figures clearly show that users are primarily relying on internal resources to satisfy data centre needs.

A very noticeable exception is the United Kingdom where nearly half of users are expecting some degree of use of outsourcing of data centre services. This confirms the advanced stage of development of the UK FM marketplace as well as the difference in maturity of mentality reported on the British market.

- In this context, hardware manufacturers have managed to take increasing share of the services marketplace. 31% of users used their hardware vendors as their primary provider of systems integration and outsourcing services. In comparison, only 24% of users appealed to ISVs, and 35% of users reported a use of a mix of both categories. There are few country specificities, except for the French market where only 25% of users selected their hardware manufacturers as their primary source of services.

By leveraging on their image of technology providers, hardware manufacturers have managed to take control over large shares of the systems integration marketplace. The question now is to know to what extent this strategy will suffice in the future. Users will increasingly concentrate not so much on technology in itself but on the returns of IT investments in the development of their business. In this connection, services providers, and particularly those with a capacity in management consultancy, will be able to compete ever more effectively.

5. Technology Trends

As users' emphasis is increasingly shifting from hardware-related priorities to IT productivity and development issues, software technological evolutions tend to acquire a key role in the European growth model. The increasing involvement of the end-users community in development and data access activities, as well as the willingness to make efforts to increase returns on software investments, will help CASE and object-oriented technologies become privileged investment domains.

- CASE: the European Case marketplace is very developed in the United Kingdom, France and Germany. It is expected to grow at a 16% CAGR until 1998. User organisations are becoming increasingly aware that a more efficient control of the evolution of their DP budget goes through more rational software development and maintenance methodologies. In addition, a large proportion of the growth will be attributable to client/server solutions that will rapidly get significance among mainframe installations.

Technical versus commercial CASE

The technical Case market has focused for a long time on the engineering elite, using Case tools to design and test process control and embedded systems. Products provided are complex, integrated environments or high-end tools. The commercial Case market places less emphasis on meeting performance specifications and testing performance at the specification level, than on how the system is built.

However, given the increasing complexity of distributed applications, the desire to downsize to networked CPUs, and the ability to test response times before the system is implemented will increasingly be required. Consequently technical Case vendors will see increasing opportunities at commercial Case user sites. By moving the performance problem upstream in the design life cycle of commercial applications, technical Case vendors will develop a competitive edge.

In parallel products will become technically increasingly integrated. The availability of open software platforms like Windows or Unix, and of graphical user interfaces, enables a more efficient communication of products from different sources between them. This facilitates the integration of new software technologies and represents a very important factor in the adoption of Case.

The market will experience an increasing pressure on unit prices. The data community will become ever more price conscious as a consequence of falling hardware prices. Central data processing departments, the de facto, contact for selling CASE, will be pressured to cost reduc-

tion. Unit prices will be under pressure from low-end tools (and particularly Windows-based tools) originated from the PC market.

- Artificial Intelligence/Expert system: the AI/expert system tools market is in the process of fundamental transformation. Rule-based functionality will gain importance as they are more often embedded in other development tools. Vendors in this market are rapidly moving out of the AI shell business and into the general purpose program development tools market with a focus on the more complex challenges such as downsizing, selectable graphical interfaces, and distributed applications.

The fate of the AI market is a testament to the liability of products that require long system design cycles to be useful. AI was never endorsed as the solution by industry leading companies in the way relational DBMS technology was. Also, the development of specialised object-oriented libraries will maintain a competitive advantage and support prices in many diverse niches.

6. The Driver of European Growth

The European market for software and services is set to undergo profound changes at the turn of the century. Drawing a clear picture of its future shape is a difficult art as technological, market and customer behaviour-related factors are going to interact to define the new boundaries of the European model.

However, the first years of this decade have already outlined the key drivers that all participants, both on the demand and on the supply sides, will increasingly focus on in the future. The software environment of users will undoubtedly gain in complexity and in flexibility through the increasing use of distributed architecture. Users will pay more and more attention to the price of their software supply and the dichotomy between falling hardware prices and stable software ones will become less and less true. In addition, users will also look for less expensive services supply inducing sometimes damaging dumping and off-shore strategies on the vendors side.

Globally speaking, as the market matures and as users gain more influence on the market evolution, the competition will become tougher. The relationship between users and providers will tend to strengthen and to tighten as market-shares protection strategies become more crucial and as going beyond IT-related issues to address management-related problems will become vital for services vendors contending with business process re-engineering.

Software and services will be the main engine of the whole European IT market until the end of the decade. There will be several key driving factors.

Software products

Distributed computing architectures

European users will be increasingly evolving towards distributed computing architectures. This means that users will be trying to fulfil their needs in terms of IT productivity and data access capabilities. This also corresponds to a change in user organisations: inter-organisational functions are communicating more freely, jobs are becoming more multifunctional, etc. This will have important consequences especially on the minimum required degree of portability of applications. Furthermore, applications will be more "communicative": interconnection and EDI capacities will be "musts" as organisations become leaner and as functions such as warehouse or inventories administrations tend to be substituted.

Besides these technological requirements, vendors will have to adapt to a shift in the decision-making process. More decisions will be made at the customer contact as management layers tend to be eliminated. The advent of the concept of networked enterprise will give priority to a customer-driven focus in the strategy of software vendors who will have to multiply contact at client level to adapt to a bottom-up, decentralised decision making process.

Software pricing issues will tend to become increasingly strategic

The way software is developed and used is dramatically changing in the enterprise. The proliferation of personal software use as well as the accelerated migration to networked topologies will increasingly require the adoption of new licensing principles. Application architectures by evolving from host-based batch processes to include host-based interactive processes, cooperative processes, and distributed processes are making traditional license models (tier-based and personal computer use-based) ever more obsolete.

Models will increasingly have to take into account the fact that the mission of software has now extended beyond the bounds of information services organisations, causing a fundamental change in the perceived value of software to the enterprise. Models will have to reflect the customer's perceived values of software and ease the software purchase cycle. Users will be increasingly demanding that software costs be un-coupled from the runtime environment and related more closely to the benefits of software to the organisation.

Software distribution issues

The economics of software production, marketing and distribution will be one factor that leads to the increased separation of production from distribution in the software industry. Faced with increased costs to obtain mind share, small innovation companies will seek to specialise in R&D and will sign up partnership agreements with larger software companies with established distribution channels or entries to customers in particular markets. More companies will be created as "integration experts" that will add value by facilitating the interoperation of purchased applications or tools. Partnerships with non-software companies will increase.

Professional services

The thrust of hardware manufacturers

- On the professional services side, important competitive evolutions are expected. Firstly, systems manufacturers will increase their marketshares by leveraging on their competitive edges. Among other factors, their capacity to invest will be a key element. In spite of persistent financial difficulties, technology manufacturers are able to dedicate more money than most other independent software companies in the world.

However, hardware vendors will have to contend with some critical challenges. Software, and more particularly services, is often a new business for these organisations. Traditionally, services were either given free as a commodity and not made distinct from the price of systems. Learning that services are not only something that clients have to pay for, but also a business "per se", is a long process which requires, among other things, a cultural adaptation of the sales approach.

Consequently, hardware vendors will adapt their strategy developing a different approach for each vertical market based on an inventory of products and skills. They will also put into place pro-active partnerships and sub-contracting relations to fill in the gaps of their services supply.

European vendors increasingly challenged by US companies

- On the ISVs side, the thrust of US-based companies will become more visible. Systems integrators will increasingly leverage on their capacity and experience in managing large-sized contracts (Federal contracts, Department of Defence, captive markets). US-based integrators will tend to become more European and adapt to the local specifics of each individual country. They will also leverage on their key large accounts (i.e. multinational companies developing their business in Europe).
- As far as European vendors are concerned, these will be meeting with a rapidly changing environment. Software and services is gradually emerging as a strategic issue for Public Authorities both at a European level and at a national level. Governments have understood the vital importance of maintaining and of sustaining the development of a strong local software and services industry. Most central governments are defining a strategy either investing directly in the capital of critical companies or supporting the partnerships between vendors. The European Commission is very keen on lifting up major regulation barriers on public contracts.

Still European vendors are suffering from well-known traditional weaknesses (such as insufficient internationalisation, lack of definition of acquisition strategy). Key problems include the structural ones. Organisational structures are often too atomised and fragmented; because of this, many companies are losing skills and do not leverage on the knowledge existing inside of the organisations.

European-based vendors will try and address this issue in the future by adopting more matrix-like organisational structures. This should enable them to capitalise both on their technological and vertical skills.

- Another key category of vendors for the future of the European competitive environment is telecommunication carriers. Following diversification strategies and aiming at the FM, Network FM and Systems Integration markets more particularly, both US-based and European telecommunication companies are multiplying take-overs and participation stakes.

Telecoms carriers will definitely increase their share of the services market. Their resources will enable them in a few years to take increasing market shares. However, few players will be able to position themselves on the investment-intensive segments like International Network Management.

Systems integration: a new sales approach for services

- Systems Integration will take an increasing importance on the services marketplace. As the performance of the hardware market declines and is characterised by falling margins, and as the outsourcing alternative is more commonly selected by users, systems integration will gain in importance.

However, the main driving forces behind systems integration will be business issues. The changing competitive environment is causing companies to re-assess the role of information technology. The result, from a technical point of view, is that the systems required are becoming increasingly complex, and it is becoming increasingly difficult for user organisations to generate necessary skills internally.

Vendors will be responding to users' needs in very differentiated ways. Hardware vendors, for example, see systems integration as the key hardware distribution channel. They can draw important competitive advantages from their size and from their geographic coverage which allow them to compete as prime contractors. Also, their privileged relationship with major accounts is a fundamental edge.

In order to avoid the often criticised "box-shifting" problem, hardware vendors are, and will be, increasingly adapting their sales structures as well as their cultural attitude. Systems manufacturers will increase their share of the market as they adopt more vertical-oriented strategies and develop their partnerships with specialised software houses.

Services companies have made major inroads on the systems integration marketplace. Large-sized US-based vendors have been able to score many points and to compete against their European counter-parts. The financial resources needed to be successful on the systems integration market are considerable: few European companies are consequently in a well-suited position.

Many services companies are developing their management skills often by developing a management consultancy arm (in partnership or through acquisitions). A high level of competition in the services vendors community is expected which should organise itself around two poles: on one side, a small number of large international vendors, positioned on the fore-front of the market and bidding mostly as prime contractors and on the other side a larger number of mid to small-sized vendors, with a local, vertical or technological focus and developing sub-contracting relations with either systems manufacturers or other integrators.

The IT business of management consultancies will definitely grow. Management consulting firms are also putting a lot of emphasis on the market as they see it making the logical link between their development of IT recommendation and the implementation of these recommendations. One of the major strengths of these companies is their high profile amongst senior management (decision makers) in user organisations. Management consultancies are playing a key role in business process redesign which is emerging as a very important influence on IT strategy in user organisations. They can also draw benefit from a range of edges such as their independence from any hardware source.

One of the central difficulties that management consultancies will have to overcome is that they are not always yet fully accepted as systems integrators having all the necessary technical skills. They will develop their alliances and partnership strategies in order to acquire the missing skills as well as the market image.

7. The Three Major Trends of the European Market

Globally speaking, the European market is set for an increased competition both on the packaged software and on the professional services segment. In macro-economic terms this will have three main consequences.

The European market will globalise ...

Local European country-markets will increasingly open up to competition. There are currently several categories of countries with the UK standing out as the most open European market. France and Sweden are gradually becoming more internationalised: in the past two to three years, an increasing aggressiveness of foreign and particularly of US-based vendors, has been reported.

In other relatively more "conservative" countries, things are also evolving. In Germany, for example, foreign-based vendors have become ever more aggressive and important breakthroughs have been reported. The German market is gradually opening itself up as the mentality of users is changing.

... and concentrate

A fundamental trend for the European software and services market is the increased concentration. The share of the market represented by the top fifteen vendors in 1988 was 13%, it reached 17% in 1992. This is still a low figure as compared to other IT segments.

In this context, the different vendor categories have differentiated competitive edges. Hardware vendors will report major breakthroughs on the services side by developing their systems integration capacities as well as their systems operations skills. However, they will meet with tougher competition on the packaged software side. Given their dependence on sales of system level software, they will be handicapped in their performance by the low growth rate of this market. In addition, competition from ISVs will be tougher on the packaged software side: the big US-based packaged software companies are now positioned as market leaders which often control software technology and influence the pace of innovation. As they reach a high level of critical size and report lower average growth rates, they will increasingly compete to defend and strengthen their market positions.

In this context, local small and mid-sized software and services vendors will tend to lose marketshares. The aggressiveness of global players and of other vendor categories (systems manufacturers, telecoms carriers, VARs, etc.), the advantage that large-sized US-based systems integrators can draw from their critical size, etc. will determine that an increasing number of European-based companies will re-focus their strategies on niches or merge with other groups. As far as the large-sized European vendors are concerned, these should be able to increase their marketshares provided they internationalise and solve their financial difficulties.

% Market share	1992	1993	1994	1995
Software products				
Hardware vendors	43	43	41	40
Independent software vendors	57	57	59	60
Professional services				
Hardware vendors	15	15	16	16
Independent software vendors	85	85	84	84

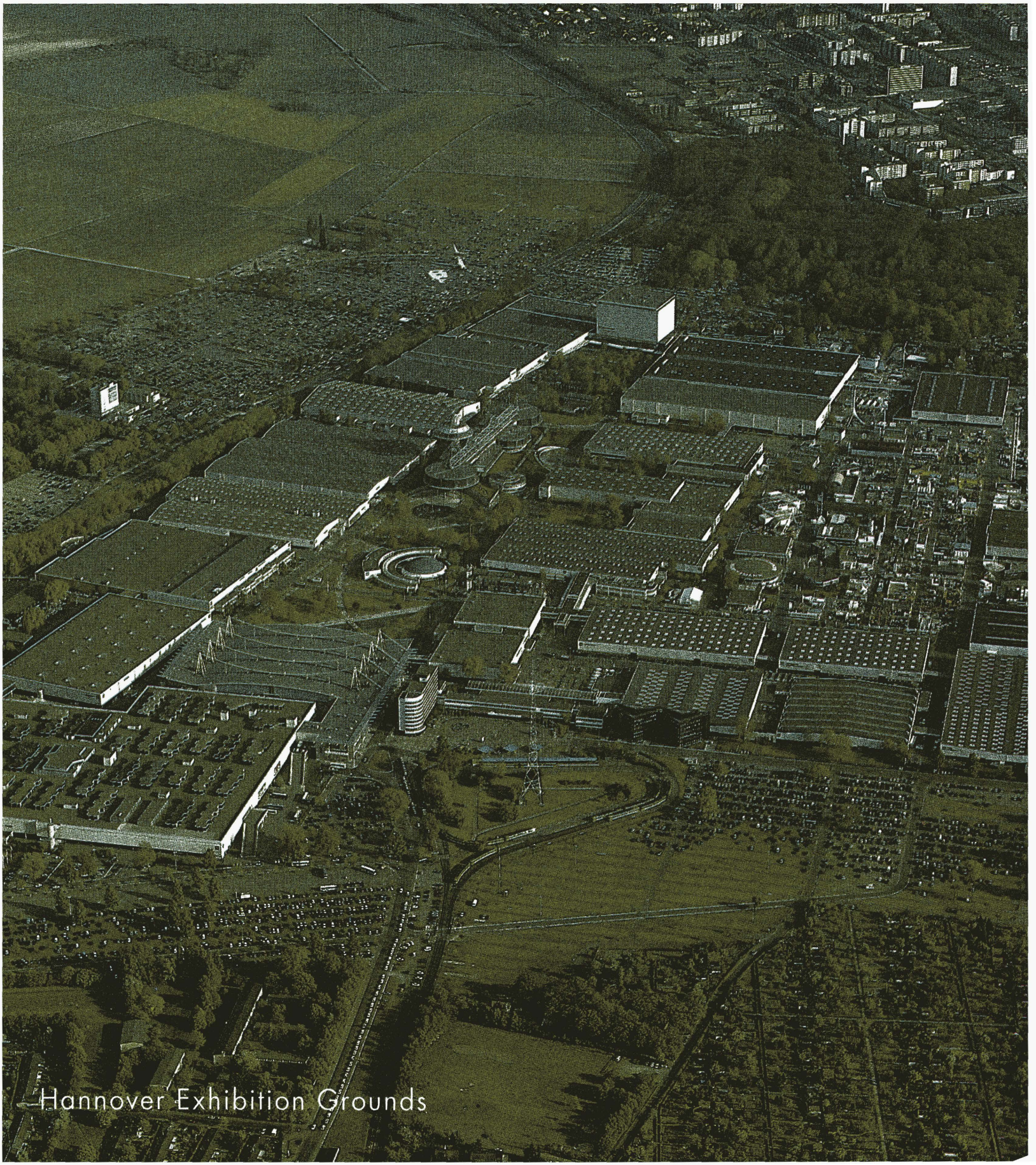
Table 9
Software Products and Professional Services Market Shares by Type of Vendor. 1992-1995

For many software and services vendors, this will mean specialisation

As the market develops and matures, it will become evident that few players only will be able to be global in terms of coverage of the market. Furthermore, the need of large-sized players to collaborate with smaller vendors in order to address mid to small-sized businesses will enable local companies to position themselves as an intermediate with a high degree of specialisation.

This will be a key opportunity for European vendors with limited investment capacity but with a high level of knowledge of their local markets. These will be able to position themselves as high value-added partners mediating and interfacing between user organisations and large generalist integrators.

One major consequence is that staff training will become a core strategic requirement. Since the competitive edge of these companies will be their capacity to provide efficient, quick and direct contact with local markets, they will have to dedicate a steady level of investment in staff training on order to maintain and increase the internal level of knowledge and skills and to increase their competitiveness.



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The Information Technology Market of Eastern Europe

This paper has been provided by International Data Corporation IDC in close cooperation with the EITO Task Force. For further statistics see also Part Three "Statistical Outlook".

1. Eastern Europe

1.1. Poised for Rapid IT Market Growth

Despite an economic recession and ongoing difficulties with reform, the IT markets of Eastern Europe are now positioned for rapid market growth. Indeed, the value of hardware shipments in several countries of the region such as the Czech and Slovak Republics and Poland increased by almost 100 percent in the 1991–92 period. This trend will continue through 1995 as Eastern economies move to stability and eventual growth in output. Indeed, the need to modernize a broad range of infrastructure and basic services, such as banking, insurance and government administration, combined with the demands of an evolving private sector, will drive strong computer hardware market growth throughout Eastern Europe well into the latter 1990s *Figure 1* illustrates that Compound Annual Growth Rates (CAGRs) for the region far exceed the combined average of 2.0 percent for the

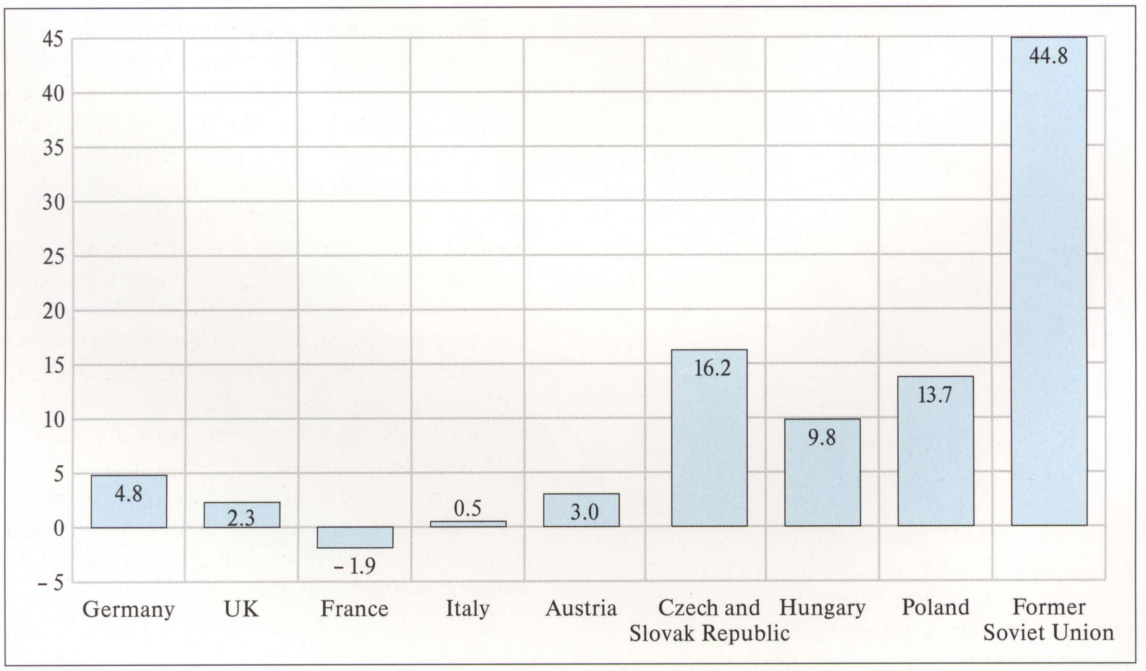


Figure 1
East versus West: Compound Annual Computer Hardware Spending Growth Rates, 1993-1995 CAGR (%)

Table 1
Value of Computer Hardware Shipments (Million ECUs) in Eastern Europe, 1991-95

	1991	1992	1993	1995	CAGR 1993-95 (%)
Czech and Slovak Republics	176	349	352	475	16.2
Hungary	207	236	259	312	9.8
Poland	185	282	317	410	13.7
Former Soviet Union	592	290	474	993	44.8
Total	**1,160**	**1,157**	**1,402**	**2,190**	**25.0**

Table 2
East versus West: Country Market Comparison of Computer Hardware Spending (Million ECUs)

	1992	1993
Czech and Slovak Republics	349	352
Hungary	259	236
Poland	317	282
Former Soviet Union	290	474
Germany	10,434	10,049
United Kingdom	6,733	6,668
France	6,742	6,181
Italy	3,911	3,710
Spain	2,518	2,208
Austria	834	857

markets of Western Europe. Eastern Europe will continue to have one of the fastest growing IT markets in the world over the next decade.

1.2. East versus West – IT Hardware Market Sizing

After a slight contraction in the 1991-92 period due to difficulties in the former Soviet Union, the regional Eastern European market resumed its course of rapid growth in 1993 with an overall increase of 21 percent in value over the previous year. In 1992, total computer hardware spending in the Baltic States, the Czech and Slovak Republics, Hungary, Poland and the Commonwealth of Independent States reached an estimated ECU 1.4 billion.

One source of growth potential stems from the small size of the average IT hardware market in Eastern Europe. An analysis of IT expenditures reveals that hardware spending in the region is still much lower than that of the average country market of Western Europe, despite extensive programs for the revitalization of IT infrastructures. In fact, the estimated ECU 1.4 billion devoted to IT hardware procurement in 1993 in the Czech and Slovak Republics, Hungary, Poland, the CIS Baltic States depicted in *Table 2* ranks with expenditures only in some of the smaller markets of Western Europe, such as Austria and the Scandinavian states. This figure also comprises only a fraction of the ECU 10 billion in IT revenues attained in 1993 for Europe's largest market, Germany.

The comparative analysis of the ratio of IT spending to Gross Domestic Product (GDP) illustrated in *Table 3* provides another indication of the growth potential embodied in the Eastern European marketplace. Despite a number of large-scale projects in banking/financial services and government administration, the region's investment in computer hardware is still well below the rest of Europe. Whereas the ratio of computer hardware spending to GDP in 1992 borders on 1 percent for select Western European countries, average expenditures for the evolving Eastern European marketplace fall consistently below 0.5 percent, with the exception of Hungary. Although the economic reform process and the need to build basic infrastructure are driving IT market growth, they have not had the anticipated impact of increasing overall spending levels to those of Western Europe.

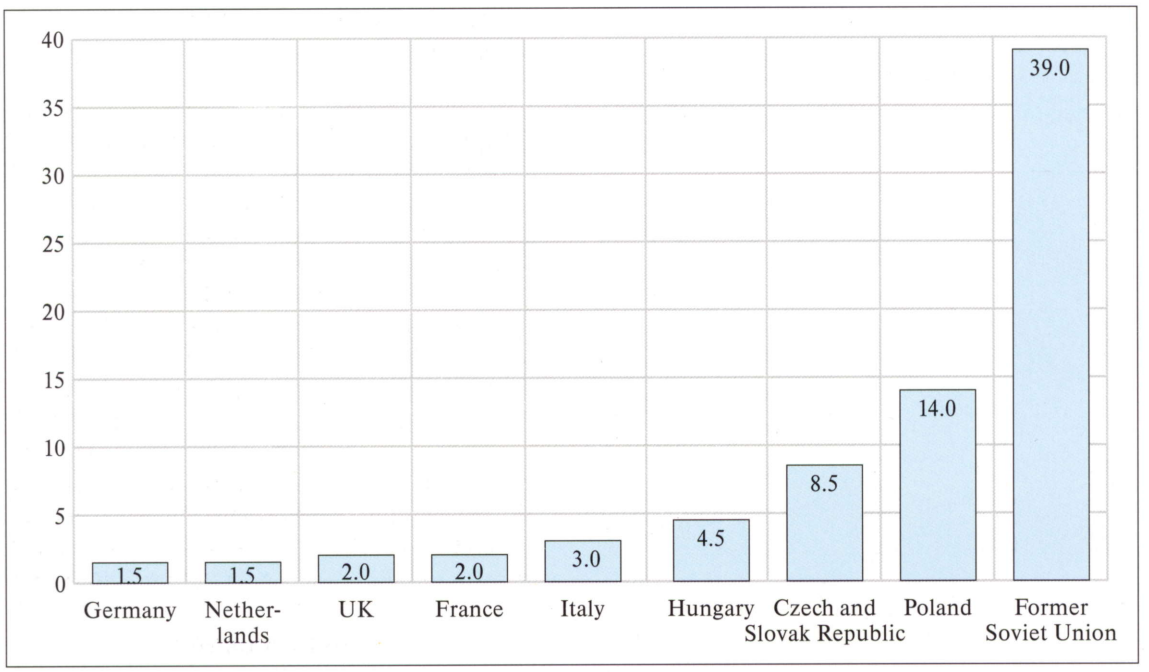


Figure 2
East versus West: White Collar Workers per PC Installed, 1992

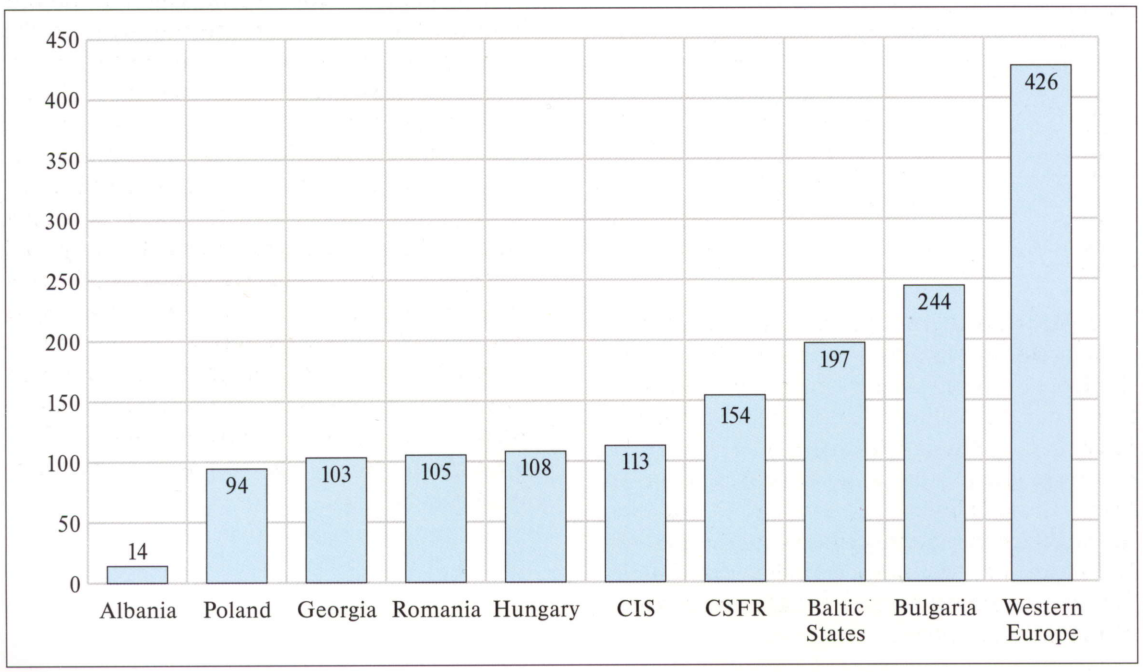


Figure 3
Lines per Thousand Population (1991)

Source: ITU, OECD

Table 3
East versus West: Ratio of Computer Hardware Spending to GDP, 1992

	%
Czech and Slovak Republics	0.38
Hungary	0.44
Poland	0.17
Former Soviet Union	0.05
Germany	0.90
United Kingdom	0.89
France	0.70
Italy	0.50
Spain	0.74
Austria	0.78

Table 4
Eastern Europe: Computer Hardware Value Category Comparison, 1991-95 (Million ECUs)

	1991	1992	1993	1995	CAGR 1993-95 (%)
Multi-user Systems	304	198	246	408	
Personal Computers	640	669	787	1,223	
Workstations	13	33	55	91	
Printers	204	257	313	468	
Total	**1,160**	**1,157**	**1,402**	**2,190**	**25.0**

Further evidence of the considerable pent up demand for information technology throughout the Eastern European economies can be drawn from a comparison of white collar workers to PCs illustrated in *Figure 2*. Whereas one to two PCs are installed for every white collar work in Germany, the United Kingdom and the Netherlands, the corresponding figures for the Eastern European countries range from just over four in Hungary to almost forty in the Commonwealth of Independent States.

1.3. IT Hardware Category Comparison

Table 4 demonstrates that the country markets of Eastern Europe remain heavily oriented to personal computers and PC-related technologies, which have accounted for the largest percentage of shipment value over the last two years in comparison to all other hardware categories. Similarly, the low-end office equipment segment has experienced considerable market growth. The renewed demand seen for multi-user systems reflects the increasing number of projects currently underway to establish basic IT infrastructures in communications, financial services and public administration. The market for mainframes, minicomputers and Unix stations rebounded in 1993, rising by an estimated 70 percent in terms of value over the previous year.

1.4. Telecommunications

The modernization of telecommunications infrastructure forms an integral part of the economic reform process in the Eastern European region. The scale and needs in this sector are enormous, with estimates of the required funding needed to bring existing systems to the average line penetration rate of Western Europe ranging from ECU 115 to ECU 195 billion. Nonetheless, the problems are both daunting and manifold. Much of the existing network comprises technically obsolete equipment dating from the 1950s, while potential subscribers must still wait 5 to 10 years for basic connection (see *Figure 4)*. Local PTTs also suffer from an acute lack of capital investment *(Figure 5)*, management shortages and massive overmanning and redundancies.

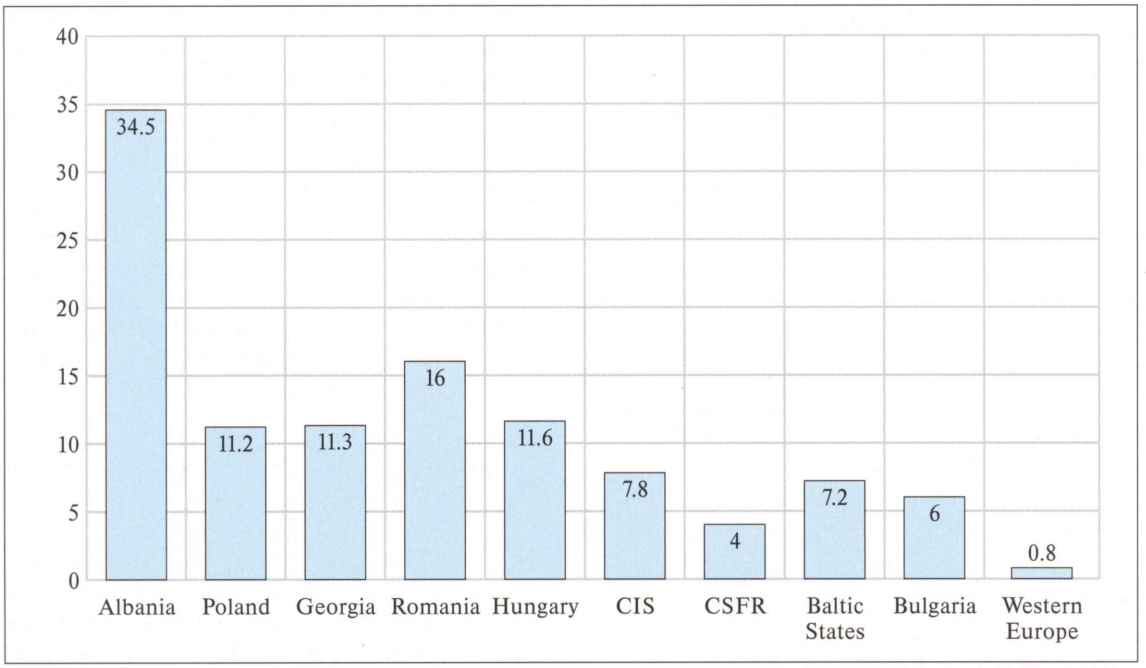


Figure 4
Waiting Time in Years for Basic Telephone Connection (1991)

Source: ITU, OECD

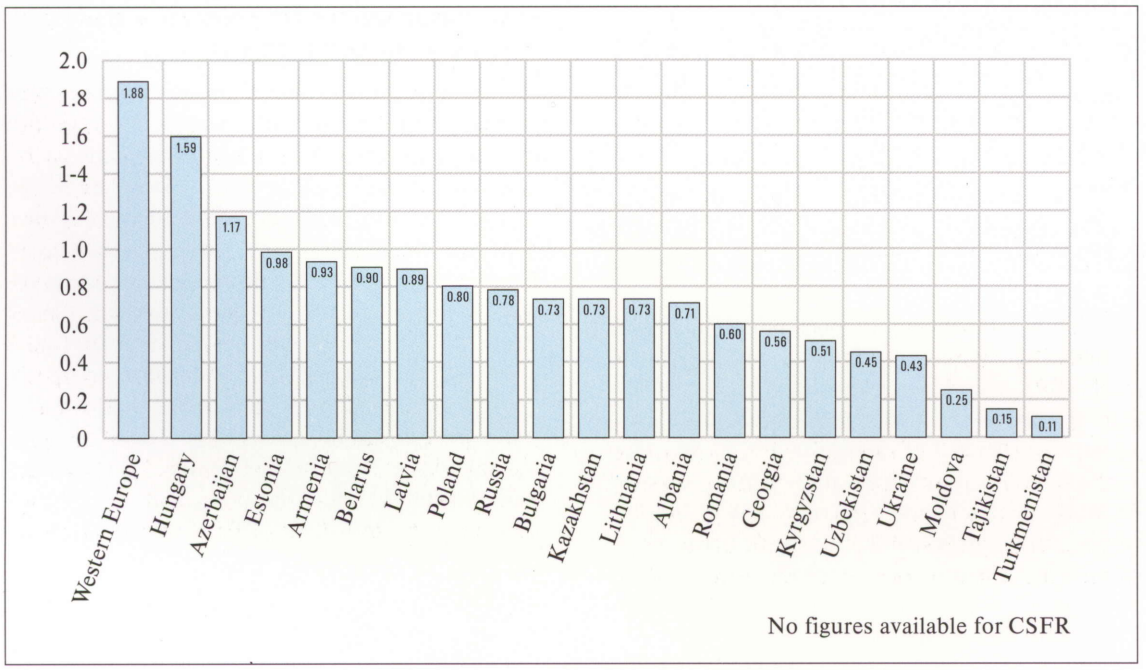


Figure 5
Telecommunications Revenue as % of GDP (1991)

Source: ITU, OECD

Table 5
Telecommunications Network Development in Eastern Europe, 1993

	Gateway	Cellular	Overlay
Armenia	E	N	P
Azerbaijan	P	N	P
Belarus	E	N	N
Georgia	P	N	N
Kazakhstan	E	N	P
Kyrgyzstan	P	N	N
Moldova	P	P	N
Russia	E	E	P
Tajikistan	P	N	N
Turkmenistan	P	N	N
Ukraine	E	P	E
Uzbekistan	P	N	N
Estonia	E	E	P
Latvia	E	E	E
Lithuania	E	E	P
Czech Republic	E	E	E
Slovak Republic	P	E	E
Hungary	E	E	P
Poland	E	E	E

Key: Established (E), Planned (P), None (N).
Source: Business Central Europe, 1993

Almost all Eastern European countries have launched telecoms modernizations programs in the 1991-93 period, with development targets set at increasing penetration rates to around 30 lines per capita. The task of upgrading infrastructures in the face of limited funding and time has led PTT authorities in the region to determine investment priorities and focus resources on those elements of the network which can produce immediate returns. Short term investment is being directed toward quick solutions such as overlay networks, cellular communications and international gateways for major urban and business centers, with long term plans emphasizing less profitable line development for residential and rural areas. While most mobile networks in place are NMT 450 MHz-based, the East European states have indicated their intention to use Groupe Speciale Mobile (GSM)'s 900 MHz band for cellular telephony in the future. The level of network development in the region is summarized in *Table 5*.

Two crucial factors influencing the pace of telecommunications modernization are the availability of finance and investment by outside telecommunications vendors in production facilities and services. Expansion plans rely heavily on external funds from organizations such as the World Bank, the European Union and the European Bank for Reconstruction and Development (EBRD), all of which have made telecommunications development a major part of financial support programs.

The Eastern European countries are undertaking extensive reforms of their telecommunications regulatory and services framework in order to attract foreign investment. Many reforms reflect the liberalization principles put forth in the European Commission's Green Paper on telecommunications such as the separation of postal and telecommunications services, the division of operating and regulatory functions and the introduction of outside competition for select services. Legislation has already been passed in several countries concerning privatization, the limits of state control and foreign ownership, and the commercialization of basic services. The outcome of PTT privatization in

the region generally entails one of the following three possibilities:

i. the creation of a public operator and basic network in which the state retains majority share, but foreign companies are allowed to participate;

ii. a consortium of financial institutions and foreign telecommunications operators (Czech Republic), or

iii. state operating companies retain a monopoly on inter-city and international networks, while local markets are open to competition (Poland).

1.5. Software and Services

The software and services market in Eastern Europe is valued at an estimated 1.24 billion ECUs in 1993, for more than 41 percent of total IT revenues. As much of the region's IT activity is confined to PCs and related technologies, most growth in this sector is derived from sales of packaged software, networking and hardware/software support services. Other sources of extensive vendor activity include IT consulting for large-scale projects in banking/financial services and government administration, and education and training.

Software and services represents the one area of the IT market where East European companies compete more effectively with their outside counterparts. Local firms have emerged to become important systems integrators, value-added resellers, support providers, software developers and training centers. They provide vital support to Western hardware vendors active in this marketplace.

Software and services represents one of the fastest growing sectors of the IT market in Eastern Europe now that it has entered the next phase of computerization. Particularly strong growth will be seen in the market for packaged software, such as application tools for database development and management, and in the demand for basic services such as IT consulting, contract programming, education/training and networking.

1.6. Evolving Role of the European Union

An increasingly important aspect of IT development in the Eastern European region is the function of international organizations and the international lending community in providing finance and support. The European Union, in particular, is playing a key role in providing much needed assistance in devising standards, and in allocating financial resources for the computerization of public administration, transportation, environmental protection, energy and other areas of basic infrastructure. It has also become the leading partner for trade in the region accounting for more than 50 percent of total turnover in Hungary, Poland and the former Czechoslovakia in the 1992-93 period.

The basis for the European Union's relations with the more developed states of East Central Europe is the associated status accorded to them in 1991. Individual Association Agreements signed with Hungary, Poland, the Czech Republic and Slovakia entailed four general areas of cooperation as the first steps toward eventual membership:

i. *Trade:* the long term goal is to incorporate the Eastern European states into a free trade zone with Western European EU members. In the short term, customs duties and import restrictions are to gradually phased out.

ii. *Financial Support:* the EU is committed to providing financial assistance to the Eastern European countries through the PHARE Program and the European Investment Bank.

Table 6
Components of European Community Financial Aid to Eastern Europe

Program	Billion ECUs
PHARE & TACIS	4.8
Food Aid-Humanitarian Assistance	3.0
Balance of Payments Support	2.5
European Investment Bank	1.7
Other (ESCS loans, Research Funds, etc.)	

Source: European Commission, 1993

Table 7
EBRD Direct Loans for Telecommunications in Central and Eastern Europe

1991		
Country	Recipient	Value (Million ECUs)
Russia	Sovintel	4.85
Poland	PTK	44.75
Romania	Rom Telecom	142
Hungary	Matáv	90
Total		**281.6**
1992		
Country	Recipient	Value (Million ECUs)
Belarus	Belarus Telecom	32.58
Bulgaria	CPTI	32
Albania	PTT	8.5
Hungary	Westel Radiotelefon	8.6
Czech Republic	Eurotel Praha	9.4
Slovakia	Eurotel Bratislava	6.8
Total		**97.88**

Source: EBRD

iii. *Investment and Industrial Development:* the Eastern European states are to introduce standards and economic regulations which correspond with those of the Union. Incentives are to be provided to facilitate investment in the region by Western European companies.

iv. *Political Cooperation:* leaders of the EU and the Eastern European states are to meet regularly to discuss political issues, which includes observer status at the European Commission and the European Parliament.

With respect to information technology, the Union has established a wide-ranging support program consisting of several sources summarized in *Table 6*. The PHARE Program initiated in 1990 is probably the most important. It is focused on providing funding and technical assistance for a set of "core" activities including, economic restructuring, privatization, labour market reform, public administration development, financial services and training. The Program has commiteed ECU 46 million for IT projects in the 1990-93 period, with an additional ECU 50 millions lated for 1994. IT investment can be divided according to the following sectors: customs (45 percent), statistics (30 percent), land registration (10 percent), finance (5 percent), other (10 percent).

The EU has also loaned ECU 1.3 billion to the region through the European Investment Bank (EIB), and it established the European Bank for Reconstruction and Development (EBRD) in 1990-91 to support private sector initiatives. Both organizations have been heavily involved in providing financial resources for telecommunications development. The EBRD has devoted considerable funding to this task, as illustrated in *Table 7,* with over 30 percent of its loans going to telecomms projects during its first year of operation. Moreover, the bank has produced a policy plan for the region, entitled "Telecomms Operations Policy," which supplements a working paper put forth by the EU Council of

Ministers concerning Community support for telecommunications development. The original EU report from 1990 outlined the following objectives: information exchange with emphasis on standardization; integration of the Eastern European countries into trans-European systems including the Community's TEDIS II program; promotion of trade and technology transfer; training and consulting; and funding.

Finally, the Union offers financial assistance for IT within the context of an extensive array of research and development programs such as subcontracting work, VLSI training, TACIS initiatives, TEMPUS, HCM, CRIT and various workshops. The EU has introduced three Framework Programs in the 1987-1994 period, each of which contains some element of IT expenditures. A fourth initiative to be launched in 1994 entails IT spending of ECU 3.9 million. In 1992, the Union provided ECU 55 million in funding for 2,530 fellowships, 200 networks and conferences, 20 joint research projects and 280 other existing programs.

2. The Czech and Slovak Republics

2.1. Economic Development

The transformation of Czechoslovakia (CSFR) into two sovereign states on January 1, 1993 has had strong economic implications for both Republics as the introduction of new customs duties, tax regulations and currencies produced a sharp decline in bilateral trade. Although separation has aggravated the economic situation in both countries, it appears to have been more costly for Slovakia with its economy dominated by energy-intensive arms and other heavy industries. While the Czech economy is indicating signs of stability, the Slovak economy is faced with unemployment now bordering on 17 percent, a rising state budget deficit, low foreign currency reserves and a significant number of major companies in financial difficulty.

	1991	1992	1993*
Gross Domestic Product (Change %)	- 19.0	- 6.7	- 2.0
Industrial Production (Change %)	- 24.4	- 10.6	- 4.0
Share of Private Sector in GDP (%)	N/A	N/A	25
Consumer Price Index (Change %)	61.1	11.2	19.0
Unemployment Rate (%)	4.1	2.6	3.8
Current Account Balance (Million ECUs)	- 260	880	41
Registered Joint Ventures	3,000**	6,295	N/A
Labour Force (million) 1.93:	5.5		
Population (million) 1.93:	10.3		
Total Foreign Investment (Billion ECUs) 12.92:	1.2		
Committed Downstream Investment (Billion ECUs) 9.93:	2.8		
Total Foreign Debt (Billion ECUs) 1.93:	5.3		

* EIU Forecast
** Both Czech & Slovak Republic
Source: Economic Intelligence Unit, OECD, Business International, National Statistics, PlanEcon, UBS

Table 8
Czech Republic: Economic Indicators, 1991-93

The partition of the CSFR accelerated the ongoing decline in GDP and industrial production seen since 1989. The combined GDP for both Republics fell by almost 25 percent through 1992. Similarly, industrial production has undergone a dramatic slide of close to 40 percent since 1990 due largely to the specialization of local industry on machinery and industrial goods destined exclusively for the now defunct markets of the former Council for Mutual Economic Assistance. While the Czech Republic appears to have

Table 9
Slovak Republic: Economic Indicators, 1991-93

	1991	1992	1993*
Gross Domestic Product (Change %)	- 15.8	- 6.0	- 9.0
Industrial Production (Change %)	- 10.6	- 16.0	- 10.0
Share of Private Sector in GDP (%)	N/A	20	N/A
Consumer Price Index (Change %)	61.8	10.1	36.0
Unemployment Rate (%)	11.8	10.4	17.0
Current Account Balance (Million ECUs)	- 471	- 628	154
Registered Joint Ventures	N/A	2,825	3,950
Labour Force (million) 1.93:	2.70		
Population (million) 1.93:	5.30		
Total Foreign Investment (Billion ECUs) 12.92:	0.25		
Committed Downstream Investment (Billion ECUs) 9.93:	N/A		
Total Foreign Debt (Billion ECUs) 1.93:	2.4		

* EIU Forecast
Source: Economic Intelligence Unit, OECD, Business International, National Statistics, PlanEcon, UBS

slowed the rate of decline in 1993, industrial production in Slovakia is expected to fall by an additional 10 percent.

The Czech and Slovak Republics have traditionally maintained the lowest level of inflation in the Eastern European region. The former CSFR federal government made low inflation a centerpiece of its economic reform program, undertaking a major effort to combat price liberalization-induced increases with a mixture of tight monetary and fiscal policies. While the combined rate for the two Republics jumped sharply in 1991, change in the consumer price index was reduced to under 11 percent in 1992. Wage pressures, new value-added taxes and immediate impact of the partition are threatening to push the annualized inflation rate to more than 20 percent in the Czech Republic in 1993. A government's growing fiscal deficit in Slovakia combined with a devaluation of the Crown and the introduction of import duties produced a six month 25 percent rise in the consumer price in that country.

Unemployment first appeared in the former Czechoslovakia in 1990 in the aftermath of enterprise restructuring. The rate of unemployment first exceeded 6 percent at the end of 1991, much of which was confined to the Slovak Republic. Indeed, economic reform and the demise of intra-Republican trade in the wake of the partition have impacted more heavily on the labour market of Slovakia, with total unemployment projected to climb to 17 percent in 1993, compared to only 3.8 percent in the Czech Republic.

Now that the privatization process is underway, the Czech Republic is likely to become the most attractive country in East Central Europe for foreign direct investment in light of its good economic standing. The combined total for both Republics was still quite low through 1992, reaching only an estimated ECU 1.39 billion, over 85 percent of which went to the Czech Republic. This trend has continued in 1993 as total investment in Slovakia will fall far short of the ECU 300-385 million originally anticipated by the government. Despite the introduction of several incentives, potential investors continue to shy away from the Slovakian market due to a perception of economic and political instability.

After a heavy deficit in 1991, the current account balance has moved to consecutive surpluses in the Czech Republic, with the overall figure rising to ECU 880 million in 1992 in the wake of strong exports to EC countries. The sharp decline in trade between the two Republics since the partition, the continued demise of former trading partners in the East, and import restrictions recently introduced by the EU and the EFTA are likely to undermine projected current account surpluses for 1993, as trade deficits are seen in both Republics. It should be noted that the 1990-92 period has produced a complete reorientation of the former Czechoslovakia's foreign trade from the former CMEA to the EU and the EFTA. Western Europe accounted for 86 percent of the Republics' total trading turnover in 1992.

Current account deficits and additional borrowing by the federal government produced a slight increase in hard currency. Nonetheless, the relatively low level of indebtedness of the Czech and Slovak Republics continues to make them attractive markets for outside traders and investors compared to most other countries in the region. Total hard currency debt reached only ECU 7.56 billion by the end of 1992. This figure was divided according to a 2 to 1 ratio at the outset of 1993 in the wake of the country's partition. Nonetheless, while the Czech Republic has retained easy access to Western capital markets, Slovakia's credit rating has been reduced in the face of its government's ongoing budgetary problems.

	1991	1992	1993	1995	CAGR 1993-95 (%)
Multi-user Systems	38	76	88	116	
Personal Computers	89	178	164	225	
Workstations	4	15	16	21	
Printers	45	80	84	113	
Total	**176**	**350**	**352**	**475**	**16.2**

Table 10
Value of the Computer Hardware Market in the Czech and Slovak Republics, 1991-95 (Million ECUs)

2.2. IT Hardware Market Development

The combined IT market of the Czech and Slovak Republics literally boomed in 1992 in the wake of strong year end demand for PCs and office equipment and the implementation of several large-scale projects for the development of basic infrastructure in banking/financial services and government administration. The overall value of the IT hardware market increased by almost 90 percent over the previous year, reaching ECU 407 million (see Part Three, Statistical Outlook, Table 28). Substantial growth was seen in all equipment size classes, from large-scale mainframes to low-end printers.

Fueling tremendous fourth quarter growth in the IT market was the threat of increased sales taxes, especially the 23 percent VAT implemented on January 1, 1993. Furthermore, doubts as to whether the Czech and Slovak Crowns would hold their value after the partition of the country encouraged firms as well as private individuals to invest at least part of their savings into hard commodities such as PCs and printers. Finally, December is traditionally a strong sales month as companies use up the remainder of their annual budgets.

The break-up of Czechoslovakia temporarily dampened IT market growth in 1993 as most vendors paused to redevise their local marketing, distribution and support strategies. The erection of border controls and the introduction of separate currencies forced most IT companies to establish a second subsidiary, distributor or representative office in the Slovakian capital, Bratislava, along with new staffs, support infrastructure and distribution facilities, as trade between the Republics came to a standstill. Trading became difficult once the the currency exchange mechanism between the two Republics was pegged to the ECU, which produced at least a 7 percent price differential between the two types of Crowns. In practice, currency exchange pecularities have resulted in trade for some IT products among the Republics being more expensive than between one of the capitals and Austria, Germany or Hungary.

Another consequence of the country's dissolution is that two fundamentally different IT markets appear to have emerged. While the financial stability of the Czech Republic continues to facilitate growth in the demand for computers of all system size classes, payment problems in Slovakia are limiting most IT procurement to personal computers and related technologies. End-users, hard-hit by ongoing political and economic reforms, are either not able to afford expensive systems, or seem reluctant to make considerable investments at the present time. The Slovakian government has also introduced a new customs tax regime on all imported goods as a form of protection for distressed local manufacturers. The immediate consequence has been a substantial price increases on all imported goods as well as higher inflation.

IT firms in both Republics are nonetheless undergoing severe financial constraints due to drastic price reductions on PCs and office equipment, and increases on the fixed costs of doing business. In 1992, they were required to sell almost twice as many units in order to achieve the previous year's revenues. In response, many companies are seeking ways of anchoring their businesses with products and services that have lower fluctuations in margins. Others are restructuring, refining sales and marketing strategies, and cutting costs by reducing their locations and forgoing dealer or VAR networks. This is being done by franchising remote offices, or developing direct marketing campaigns. Company staffs are also being kept to a minimum, while those employees remaining are more highly trained and potentially better paid than before.

Potentially the most important single trend evolving out of the 1992-92 period is the clear decision of local end-users to put product quality and service support above price in making IT buying decisions. An important sign for this development is the large number of important no-name PC assemblers which have recently signed distribution agreements with name brand vendors. Furthermore, local end-users are now overlooking slight price differences, which suggests that the economy has sufficiently improved to make more expensive purchases possible.

Changes in Czech Bankruptcy law implemented in May, 1993, may also influence developments in the IT market. For example, a number of prospective clients in the manufacturing sector may be forced into insolvency once they are audited. Since the 1989 Velvet Revolution, some enterprises have been carrying huge debt loads simply to avoid laying off employees. Local suppliers were willing to agree to the non-payment of debt to ensure ongoing employment for their own workforce. New laws now mandate that organizations may not operate at a loss, or simply trade debt among themselves, in order to guarantee employment.

2.3. Telecommunications

The current state of the telecommunications infrastructure in the Czech and Slovak Republics still represents one of the most serious obstacles to the development of a market economy. The former communist regime invested little in telecommunications development over the years with the result that the current analog network is overburdened, obsolete and completely lacks any modern equipment at the higher levels of technology. With a call completion rate of 45-48 percent in 1991, over 60 percent of the country's telephone exchanges dated from the 1950s, with most switching based on Strowger and Crossbar technology. Outstanding orders for new lines stood at almost 420,000 in 1990 and at roughly 300,000 in 1992.

Table II illustrates that the telecommunications backbone system in operation in the Republics in 1990 consisted of two analog, circuit-switched networks with 2.3 million main lines and a telephone penetration of only 14.8 per 100 inhabitants. Both the distribution of lines and telephones among the Republics roughly corresponds to the size of their respective populations, with 70 percent of all equipment installed in the Czech Republic and 30 percent in Slovakia.

In 1991, the former Federal Ministry of the PTT presented the Czechoslovakian government with a comprehensive plan to upgrade the local telecommunications infrastructure entitled the *Draft Strategy of Communications Development.* The basic aim of the ten year program is to modernize the given network in the shortest time possible through digitalization and to increase the existing trunk network to 5.6 million direct exchange lines by the end of the decade. It calls for the development of a unified national digital network with ISDN capabilities as well as data and cellular communications for business operations. The plan entails the following stages:

	1990	1995	2000
Lines	2.31	3.45	5.621
Telephones	4.3	0.0	0.0
Main Lines/100 Inhabitants	14.8	21.7	35
Phones/100 Inhabitants	31.3	41.0	70.0
Packet Switched Data Network	6,100	16,200	70,000
Telexes	12,000	N/A	10,440
Planned Telecom Investment 1991-2000		ECU 3.54 billion	
Planned Cellular Comm. Subscribers 1991-95:		13,000 GSM 900 MHz 60,000 NMT 450 MHz	
Planned Cellular Comm. Subscribers 2000:			170,000

Source: Czechoslovakian Federal Ministry of Posts and Telecommunications

Table II
Program Data on Telecommunications Development in the Czech and Slovak Republics

i. the expansion of the basic transmission network based on optical and radio-relay lines to link major centers;

ii. the building of additional digital overlays for international switching centers in Prague and Bratislava, as well as digital overlays for select transit switching centers and local digital networks;

iii. the establishment of local digital switching centers in areas where rapid growth can be expected in business demand for telecoms services;

iv. the transfer of existing high use subscribers to new digital switching centers; the 4 percent annual growth in the installation of main lines seen in the 1985-1990 period is to be accelerated to more than 10 percent through the year 2000.

The total investment required to reach the penetration target of roughly 35 lines per 100 inhabitants borders on ECU 3.8-5.4 billion according to the former Federal PTT's planning study.

The governments of the Czech and Slovak Republics have already earmarked ECU 3.5 billion for telecoms investment through the year 2000, which is to be financed through a combination of loans (5 percent), local SPT resources and user revenues (80-90 percent) and privatization shares (10-15 percent). Credits from the international lending community have only become an important factor in 1993. The SPT Telecom in the Czech Republic has now borrowed up to ECU 185 million from the World Bank, the EBRD and the EIB. The EBRD has also provided ECU 44 million in funding for an ECU 272 million project to upgrade Slovakia's telecommunications infrastructure. The PHARE Program has donated ECU 6 million for local telecoms development.

One of the biggest challenges facing both governments is the proposed privatization of their respective PTTs, the SPT-Praha and the SPT-Bratislava. The Ministry of Transport and Communications, which formerly held monopoly control over the provision of public data and transmission facilities and services, was abolished in 1992 in anticipation of the country's partition, with powers and responsibilities being transferred to the Republican-level Administrations of Post and Telecommunications (SPT). While the Slovakian government continues to deliberate on the future status of its SPT, the Czech Republic has introduced a plan to transform its organization into a joint stock company with majority (51 percent) ownership by the state, 46 percent by privatization coupon holders and 3 percent for restitution.

Despite privatization, each SPT will retain a monopoly on basic services in its territory, including the construction and operation of the basic telecommunications network and related telephone services. Services to be offered under licenses in a non-monopoly environment include public data network services, cellular network services, paging systems, telematic services and data communication of documents. Competition is also allowed for the distribution and maintenance of terminal equipment such as PABXs, modems and terminals.

The SPT Praha and SPT Bratislava have already introduced a radio telephone network, a packet-switched public data network, and a paging system through joint venture companies. A public NMT 450 MHz analog cellular network first went into operation in 1991 with 3,000 subscribers, with the total number of users projected to reach 60,000 by 1995. The system is overseen by joint ventures between the SPTs and a consortium of US companies which have a 20 year exclusive agreement on NMT 450 MHz radio services in the Republics. It is anticipated that the Czech and Slovak Republics will also seek to link up with European GSM once the 900 MHz bandwith, formerly used for military and defence purposes, is reallocated for civilian use.

The same organizations also provide packet switched public data services (VDS) based on an X.25 network established in 1991, which incorporates 26 nodes and access modules in both Republics. A VSAT satellite service was more recently launched, through a hub-station in Prague, which offers communications via Intelsat or Eutelsat. Data services are to be expanded to enhance document communication by telefax and electronic mail services.

Several local financial institutions and insurance companies rely upon the few existing private data networks to conduct everyday data communications. Banks such as the Ceska Sporitelna, the Komercni Bank and the Investicni Banka are building their own private networks. The Investicni Banka has established a private X.25 network for 15 branches in the Czech Republic, which are engaged in 1 million transactions per day for over 750,000 customers. A computer vendor has also set up a high-speed digital network overlay to supplement existing microwave links, currently used for radio and television broadcasting.

2.4. Software and Services

Software and services expertise in the Czech and Slovak Republics was traditionally concentrated in state organizations ranging from IT institutions to the military. Indeed, the market's major local software companies have all evolved from various cooperatives, army youth organizations, and party organizations for youth and students.

Today, software and services represents the one sector of the IT market in the former CSFR where local firms have competed most effectively with outside vendors. In fact, the market's leading systems integrator, PC software vendors and value-added resellers all consist of local software houses. They are particularly active in the packaged software market for single-user platforms, as well as the development of customized application solutions for multi-user systems.

This also includes Unix, application tools and education and training. Unix expertise in the Czech and Slovak Republics is concentrated in a few large software houses and an array of smaller value-added resellers, the majority of which are involved in providing Unix-based applications and support for client server configurations, particularly high-end personal computers and workstation servers. Many local software organizations have also identified the education and training of local MIS professionals as a lucrative part of the market, in particular for Unix, open systems, networking, relational database technology and applications.

Nonetheless, Western software and services companies now control a large part of this market which was valued at ECU 179 million in 1992. They are well positioned in the subsectors for packaged software, for both PCs and multi-user systems, application tools, in particular relational database management systems, maintenance support and professional services. The Czech Republic does have the most dynamic market for relational database management systems (RDBMS) in the East Central European region.

2.5. IT Skills and Expertise

The level of computer skills in the populace of the Czech and Slovak Republics was traditionally considered low relative to the other countries in the region due the genuine neglect in computer education, the lack of training opportunities, and stringent restrictions placed on the private import of personal computers, which might have compensated for the scarcity of locally manufactured machines. Czechs and Slovaks also did not have the access to information on Western computing technology that Poles and Hungarians, or the media-dependent East Germans had. Policies of the former communist government regime also discouraged private computer ownership.

In 1985, the Czech and Slovak Ministries of Education did launch a 10 year program to computerize schools and compensate for shortcomings in IT education. A number of state IT organizations also provided training in computer application and programming. For example, each larger city in the former Czechoslovakia had a Dom Techniki CSVTS, or House of Technology, which engaged in the local education of computer specialists. Moreover, former republican-wide distributors Datasystem and Kancelarske Stroje sponsored training programs for end-users in state enterprises.

One of the strongest areas of IT education was at the university level which generally received better funding from the government. The Technical University in Bratislava alone graduated 1,800 computer science students annually up to 1991. Today, there are an estimated 80,000 IT specialists throughout both Republics, many of whom are involved in software development and IT services.

Training by local IT companies was first initiated in the latter 1980s by several semi-autonomous JZD cooperatives and the former Mikroelektronika association which produced a special PC for youth. Local IT firms have begun to indentify the education and training of MIS professionals as a potentially lucrative part of the IT market. The number of IT companies providing training facilities for networking, software development, Unix and open systems has increased substantially within the last year, particularly in the Czech Republic. Several vendors from Western Europe have also launched IT training programs.

2.6. IT Market Outlook

The strong IT hardware market growth seen in the Czech and Slovak Republics in 1990-92 period is expected to continue. While the impact of the partition will manifest itself in limited growth in the short term, the markets will pursue their course of extensive growth in the 1994-95 period as a number of large-scale investment projects come on line in government administration and manufacturing. Overall, the information technology market in the two Republics is projected to grow by 16 percent annually up to 1995. Most shipment activity will take place at the low end of the market, particularly for small-scale proprietary systems, Unix-based machines, network servers, PCs, printers and office equipment.

Although the decentralization of local industrial associations has reduced the role of the large centralized data processing center, it has also given rise to a whole new group of end-users in the form of newly independent firms. Today, the most solvent customers in this marketplace are represented by banking and financial services, government administration, industry and manufacturing, joint ventures and large-scale investment, health services, transportation and small private firms.

The strong growth in IT seen in the 1991-93 period is partly a result of efforts to upgrade the operations and services of the local banking system with information technology. The banking industry in the former CSFR has changed substantially in only a few years. Whereas only a few state-owned banks were in operation in 1990, the current number exceeds 50 separate organizations comprising state institutions, private banks and the branch offices of foreign banks. Recognizing that an efficient and automated banking infrastructure was essential to the development of a market-based economy, the former federal government first initiated the decentralization of the banking sector in 1990 when the Czechoslovak State Bank transferred commercial activities to three other state-owned financial institutions. This development led to the establishment of a two-tiered banking system consisting of a central bank and a second level of independent, commercial banks. Subsequent legislation implemented in 1992 defined specific financial responsibilites and allowed for the privatization of state-owned financial institutions.

Government administration represents another important IT market growth sector in the Czech and Slovak Republics, as evidenced by a number of large contracts awarded in the 1991-93 period. Several high profile projects included the automation of the Ministry of Interior, the computerization of local and municipal governments in the Czech Republic, the reequipping of the Podnik Vypocetni Techniki (PVT), and the introduction of new systems into the Ceske Sprava Socialniho Zabezpeceni (CSSZ). Nonetheless, the partition of the country has created significant delays in the computerization of some government areas, as proposed projects have been temporarily shelved as both countries reorganize national and local public administration. Once

this process is completed, however, governments will play an important role in covering the costs of and overseeing the computerization of the remaining state sectors of their economies.

The international lending community continues to be one of the most important sources of funding for public tenders, even though the Czech and Slovak governments have tended to borrow less than other countries in the region, due to disagreements over the role of government guarantees. Several of the projects mentioned above are receiving some form of financial support from either the World Bank, European Union initiatives or the EBRD. While the World Bank and the EBRD have funds to the SPT Telecom for investment, the EU has been instrumental in allocating financial resources for IT development with programs such as PHARE and TACIS which support the restructuring and revitalization of such sectors as energy, public infrastructure and environment and nuclear safety. PHARE program money has been involved in projects with the former Federalni Statistika Urad (1.0-1.3 million ECUs), the Statni Banka (ECU 11.6 million), the former Federal Customs authorities and the computerization of local and municipal governments in the Czech Republic.

While no official body exists for IT strategy development in the public sector, programs for IT procurement in government administration are strongly oriented towards open systems and Unix, in order to follow similar trends in Western Europe, particulary those of the European Union in lieu of the Association Agreement, and to avoid dependencies on any single vendor. Here, the international lending community has played an influential role in setting standards and determining technical specifications for publicly financed IT projects.

Despite the difficulties entailed with the privatization and restructuring process, industry and manufacturing have become important areas of hardware market growth due to high level of outside investment in local enterprises, particularly by German and American companies. For example, the Skoda-Volkswagen contract alone generated significant hardware sales of systems of all size classes in the 1992-93 period, while facilitating the market entry of a number of software and services companies. Moreover, most hardware vendors continue to identify industry and manufacturing as areas of high growth potential.

Finally, several areas of the Slovakian economy still represent potentially lucrative markets for IT hardware vendors. For example, the country's banking and financial services sector is in the process of developing IT infrastructures to enhance its operations and competitiveness. Banks are purchasing multi-user systems and large numbers of PCs with the intention of developing such sophisticated capabilities as fiber optic and wide-area networking. A number of companies in industry and energy have also sought to upgrade IT facilities with both used and new equipment over the last two years. Many other sectors possessing sufficient funds to make IT investments seem to lack direction and professional advice in devising IT strategies. Most government agencies were still purchasing inexpensive no-name PCs without consideration of long term development plans or the possible problems entailed with such equipment with networking and integration.

3. Hungary

3.1. Economic Development

Hungary stands at the crossroads of the reform process with its Economic Program for National Renewal. While overall economic performance continued to be poor in the 1992-93 period, the first indications of a recovery are now discernable: inflation has slowed, the private sector accounts for more than 40 percent of annual GDP, unemployment has peaked, and ECU 3.96 billion of foreign investment has come into the country over the last three years. Moreover, the 35 percent decline in industrial production recorded in the 1990-92 period was confined to only - 1.5 percent in 1993. Finally, after several years of decline, total GDP is expected to increase by 2 percent in 1994.

The Hungarian government's ongoing austerity program has driven growth in the consumer price index in the 1990-93 period. While a goal of 30 percent was set for 1991 to match targets prescribed by the IMF, price liberalization and additional cuts in state subsidies pushed the inflation rate to just under 35 percent for the year. Macroeconomic stabilization policies along with depressed domestic demand kept this figure to only 23 percent in 1992. The Index appears to have stabilized at 23 percent in 1993 in the face of restrictive monetary policies. It is forecasted at only 15 percent for 1994.

Unemployment has been rising steadily in Hungary since 1990 in the wake of company restructuring, privatization, the falling away of former CMEA export markets and a significant decline in industrial production. Unemployment reached 300,000 or 6 percent of the labor force by 1991, which mushroomed to more than 13 percent by year end 1992 in the aftermath of a wave of company closures and bankruptcies. This figure is projected to peak in 1993 at 15 percent.

Hungary's Company and Investment Acts along with the country's general stability have facilitated an influx of foreign capital from foreign firms. Indeed, Hungary has attracted more investment per capita than any other country in the region with total outlays of ECU 3.96 billion by mid-year 1993, over 60 percent of which has gone to the manufacturing sector. The country also fields the largest number of joint ventures and wholly subsidiaries in East Central Europe with 16,000. The government has set the goal of raising the foreign-owned share of the economy to 25 percent by 1994.

Nonetheless, the current account surpluses maintained by Hungary in the 1991-92 period have given way to a projected deficit of ECU 308 million for 1993. This development is largely a reflection of a sharp deterioration in trade by mid-1993, as a 20 percent decline in exports and a 50 percent rise in imports produced a ECU 1.54 billion deficit. Now heavily dependent upon trade with Western Europe, protectionist trade policies of the European Union, Hungary's most important trading partner, along with the region's recession have played a key role in undercutting exports. The government has sought to enhance the competitiveness of Hungarian exporting industries through successive currency devaluations, which totalled 9 percent for 1993.

Despite the highest per capita debt in the East Central European region, Hungary maintains a good standing with its official and commercial creditors, having regularly met payments on its debt obligations. While the gross figure still stood at more than ECU 16.2 billion in 1992, the country's central bank built up currency reserves of ECU 2.23 billion to produce a net debt of only ECU 14.32 billion.

3.2. IT Hardware Market Development

Large-scale infrastructure projects in banking and government administration facilitated ongoing dynamic growth in Hungary's market for IT hardware, which increased by 10 percent of the previous year. While the PC market contracted slightly in the wake of falling prices, particularly strong growth was recorded in the multiuser systems category which more than doubled over the previous year, reaching a value of ECU 57 million. The total value of shipments for all IT hardware and office equipment size classes is estimated at ECU 277 million for 1992.

The development of the Hungarian information technology market in the 1992-93 period was heavily influenced by several factors which can be summarized as follows:

Revised status under CoCom

In 1992, Hungary became the first state of the former CMEA to be classified as a Group V country under the Coordinating Committee for Multilateral Export Controls' (CoCom) list of restricted countries for high technology exports. This step had an immediate impact on the type of equipment being demanded and shipped in the computer market by allowing exporters to apply for bulk licences for product ranges below certain specifications. For example, the country's technical workstation market, comprised wholly of once restricted RISC-based machines, grew by almost 400 percent from 1991 to 1992. The move also allowed the Hungarian government to become a member of Europe's Eureka high-technology research program in May 1992, and opened the way for a ECU 3 million PHARE rant to modernize the country's R&D infrastructure.

	1991	1992	1993*
Gross Domestic Product (Change %)	- 5.0	0.0	1.5
Industrial Production (Change %)	- 9.8	- 1.5	1.9
Share of Private Sector in GDP (%)	35	40	45
Consumer Price Index (Change %)	35	23	23
Unemployement Rate (%)	7.5	13.5	15.0
Current Account Balance (Million ECUs)	206	250	- 308
Registered Joint Ventures	10,000	13,500	16,000
Number of Economic Organizations	52,756	69,386	77,526
Number of Private Companies	0	57,000	65,000
Labour Force (million) 1.93:	4.82		
Population (million) 1.93:	10.32		
Total Foreign Investment (Billion ECUs) 6.93:	4.00		
Total Foreign Debt (Billion ECUs) 1.93:	16.50		

Table 12
Hungary: Economic Indicators, 1991-93

* EIU Estimates
Source: Economic Intelligence Unit, OECD, Business International, National Statistics

	1991	1992	1993	1995	CAGR 1993-95 (%)
Multi-user Systems	28	57	61	51	
Personal Computers	133	125	136	176	
Workstations	2	6	8	14	
Printers	44	49	55	71	
Total	**207**	**236**	**259**	**312**	**9.8**

Table 13
Value of the Computer Hardware Market in Hungary, 1991-95 (Million ECUs)

International financing & large-scale tenders

Large-scale tenders supported by the international lending community remain one of the most influential factors on the development of IT market in Hungary, particularly for publicly awarded tenders. Indeed, contracts awarded by the World Bank, the European Union's PHARE program and the EBRD served as a primary source of market growth in the 1991-92 period. Some of the most important tenders awarded over the last twelve months stem from the PHARE program including the modernization of the Budapest Stock Exchange (PHARE), the Hungarian Customs Authority, and the Central Statistical Office (KSH). Moreover, the EU has been instrumental in providing resources to assist Hungarian government institutions in restructuring their organizations to meet EC standards and procedures. For example, Hungary's twenty Registry Courts obtained a ECU 1 million grant from the Union Community for a computerized information system.

Hungary has also received funding from the EU within the context of programs for science and technology development. For example, the PHARE program has provided ECU 13 million to the Hungarian scientific community for computer networking development, which included the link up between the country's R&D network and the European COSINE. Hungary also participates in the Union's PECO Program which has provided funding and sponsored more than 35 IT projects, seminars and conferences. The country is now a full member of COST, EUREKA, ESF, CERN and EMBO, and it has a collaboration agreement with the ESA.

The demise of the local IT industry?

The 1992-93 period has proven decisive for Hungary's leading IT firms as they struggle simultaneously with internal restructuring, redefining market strategies and reducing cost structures in the face of declining prices and more sophisticated competition from outside vendors. For example, almost all of the country's major assemblers recorded lower levels of PC shipments in 1992 than during the previous year. Moreover, several major players filed bankruptcy proceedings, while many others saw a slump in turnover.

Several problems converged in the 1991-92 period to jeopardize the operations of local IT companies. Most importantly, trade and currency reform combined with international price competition produced a dramatic slide in prices and margins on PCs and office equipment, forcing a market consolidation among local companies. While name brand vendors in Hungary introduced successive price reductions, the Hungarian government has liberalized imports and devalued the forint, both of which have influenced local firms in two important ways:

i. international vendors were allowed to enter the market, thus bringing an end to the protection from outside competition once afforded to the Hungarian computer industry through import barriers, and

ii. the price of imported goods from the Far East and Western European intermediaries increased sharply due a change in tariffs designed to facilitate local assembly. In essence, the opening of the Hungarian market, economic reform, and price reductions have had the impact of making the equipment of outside vendors more price competitive.

Falling margins also caused several local companies to overleverage their financial positions, in particular those which attempted to

finance excessive overheads and expansion through extensive borrowing from local banks. The sellers market which existed for most local IT vendors through 1991 allowed them to hedge anticipated profits against bank credits and loans, frequently borrowed at interest rates exceeding 40 percent. Understandably, once local market prices and margins declined, and more competitive name brand vendors began to garner share, these same local companies became immediate credit risks as they defaulted on loan payments. With signifant debt and few avenues for additional financing, they became trapped, caught in a circle of having to pay loans and compensate for falling margins by moving even more product in a market which in the meantime had become much more competitive. While several firms turned to outside creditors, others became very dependent on large banks, tied into high interest loans, and collapsed.

In addition, a number of companies faced internal problems related to cost cutting and the tasks of reorganization and redefining IT strategies. For example, almost all of Hungary's major PC vendors underwent a period of restructuring in 1992, replacing management, reducing staff and formulating new IT policies. The lack of a clear market focus forced many local IT firms to overleverage in terms of product offering. While a closed, sellers market overshadowed the absence of an IT strategy, the entry of more competitive name brand vendors quickly revealed the shortcomings of local companies.

While some local firms have had to terminate operations, most have responded to changing market dynamics by adopting several different policies aimed at enhancing competitiveness:

i. to diversify into other IT products and streamline product offerings;

ii. to improve the quality of their personal computer and related services offering to compete with international vendors;

iii. to explore alliances with name brand vendors, while retaining hardware independence;

iv. to develop value-added services and systems integration capabilities, such as networking and consulting, with a marketing focus on large accounts;

v. to redefine IT strategies;

vi. to trim staffs.

The result has been a polarization in the market between a handful of equipment suppliers/traders and a very competitive community of value-added resellers and systems integrators specializing on PCs and Unix servers.

Compounding the problems of local firms has been a marked change in end-user requirements, which has forced them as well as brand name vendors to redefine product and marketing strategies. Although price is still important, Hungarian end-users are increasingly giving greater consideration to other criteria when buying IT equipment. Indeed, quality, along with value-added service, support and training, have become decisive factors with respect to PC procurement. This is particularly true of large accounts in government administration and banking/financial services. While banks may afford brand name equipment outright, government organizations are demanding quality machines with extensive long-term service support contracts at the lowest prices possible.

3.3. Telecommunications

Traditionally with one of the lowest line densities in the region, Hungary is now in the process of creating one of Europe's most modern telephone systems. In 1990, the Hungarian government launched a 10 year modernization program which calls for the automation of the entire public switching network with 3 million additional lines, data transmission capabilities and switching aparatus, optical fibre transmission, X.400 messaging, videotext and integrated services

Table 14
Program Data on Telecommunications Development in Hungary

	1990	1995	2000
Lines	986	1,718	3,029
Telephones	1,767	2,672	4,232
Telex Stations	14	19	29
Data Terminals	7	31	71
Waiting List (Phones/Years)	12	7	1
Main Lines/100 Inhabitants	9.4	16.4	29
Phones/100 Inhabitants	16.8	25.6	40.6
Planned Telecom Investment 1991-95		ECU 1.04 billion	
Planned Telecom Investment 1991-2000:		ECU 2.3 billion	
Planned Cellular Comm. Subscribers 1991-95		58,000 GSM 900 MHz 28,000 NMT 450 MHz	
Planned Cellular Comm. Subscribers 2000:			200,000

Source: Hungarian Ministry of Transport, Communications and Water Management, US Department of Commerce

(ISDN) (see *Table 14*). The required investment to meet the fixed target of 27 lines per 100 capita is estimated at roughly ECU 4.62 billion.

The first 3 year phase of the program was launched in 1991 with the objectives of upgrading the country's backbone data switch network with a digital overlay comprising 56 exchanges to connect 450,000 subscribers by 1993. With total planned investment of ECU 1.15 billion, it also entails the establishment of 300,000 additional lines via MATAV (Hungarian Telecommunications Company) and a further 500,000 through other telephone companies, in order to raise the number of lines from the current 10 per 100 capita to 20 by 1994.

Another important element of the development program is the restructuring of the Hungarian PTT which has functioned as an independent commercial enterprise since 1990. While regulatory functions have been transferred to the reorganized Ministry of Transport, Communication and Water Management (MTCWM), the PTT was turned into a holding company in which postal and telecommunications activities are separated into two affiliated enterprises, Magyar Posta and MATAV mentioned above. MATAV is also to be privatized in stages over a 2 to 3 year period under the supervision of the States Assets Handling Agency.

A national cellular network is also to be developed, with the projected number of subscribers projected to exceed 75,000 by 1995, and more than 200,000 by the year 2000. The existing telecommunications infrastructure has already been augmented by a 450-MHz NMT system, based on a joint venture between MATAV and a Western partner, which became operational in 1990 with 28,000 subscribers. The government also approved tenders for the development of a local 900 MHz range cellular network which meets GSM specifications.

Altogether, approximately ECU 2.3 billion has been earmarked for local telecommunications development by the Hungarian government through the year 2000. Proposed funding is to stem from three sources:

i. higher user revenues based on increased tariffs;

ii. credits from the international lending community;

iii. and foreign equity investment through privatization and joint ventures.

Since 1987, the World Bank has provided ECU 169.4 million in loans for telecommunications development in Hungary, while the European Investment Bank has provided a 15 year ECU 80 million for the first phase of the ten year modernization program. The EBRD has also dispersed amounts of ECU 8.6 million to the cellular joint venture and ECU 90 million to MATAV for the implementation of the so-called "Village Program" which foresees increasing the number of rural lines to 1.8 million.

Telecommunications development has also carried over into public data services. In 1992, the liberalization of telecommunications legislation led to the establishment of several private networks offering public data communications services, satellite-based VSAT communications and Electronic Data Exchange (EDI) to Hungarian banks and insurance companies. MATAV's Telegraph and Data Communications Directorate has also founded a wholly-owned subsidiary for the purpose of operating public data switch services. One of the most important investments made in the Hungarian banking industry has been the establishment of an X.25 national network for interbanking operations, the National Interbank Clearinghouse Giro Ltd. As of mid-1992, over twenty-five local banks were registered as shareholders, with the actual number of users reaching thirty.

3.4. Software and Services

Hungary's nascent software and professional services industry has become a significant factor in the country's foreign trade turnover over the last five years. Locally developed software represents a major share of Hungary's intellectual exports, with the three largest markets comprising Germany, Austria, and France. Today, up to 150 organizations, from leading local computer vendors to newly formed small-scale enterprises, export software and professional services to more than 29 countries worldwide. There were more than 22,800 software and service professionals in the market by 1991, 32 percent of whom were either involved in the development of software for export, or worked directly for a foreign company. Many Hungarian software organizations have highly skilled systems software and software tool design staffs.

One key to the development of this sector has been reform-induced measures introduced by the Hungarian government to stimulate investment in high technology. Formerly, a number of bodies such as the Technical Development Commission, the Ministry of Industry, the Central Statistical Office, the Academy of Sciences, and the General Post Office promoted computing technology and local software development. Today, the government, with the support of the State Office for Technical Development (OMFB), utilizes a number of fiscal and monetary tools to support the local IT industry. For example, it has introduced incentives such as tax rebates for local software developers, established so-called Technoparks, and promoted the development of "innovation banks".

It has also targeted specific portions of income tax revenues for high-technology research projects. In 1988, the Hungarian parliament passed a 4.5 percent special tax on firms as a contribution to a central technical development fund which is intended to generate some ECU 86 million in annual investment. Between 19 and 28 billion of this sum goes to the OMFB, to fund its own as well as ministry-level R&D programs. Most R&D expenditures are now channelled through this organization which allocates only limited amounts for the development of software and professional services. It received up to 2,500 applications for R&D funding for the 1991-93 period.

Table 15
Education and Training of Software Service Professionals in Hungary

Sample of Annual Number of IT Professional Graduates	1990	1993	1990-93 CAGR (%)
Universities	1,500	1,550	1
Technical Schools	2,000	3,450	20
Other			
- Certification	800	2,200	40
- Training/Studies	5-10,000	6,700	10
Total	**9,300**	**13,900**	

Table 16
Installed Base of Computers in the Education Sector in Hungary

	1990	1991	1992
Primary Schools	20,620	22,000	24,340
Labour Training Schools	3,562	3,600	3,910
Secondary/High-schools	12,602	15,000	17,780
Higher Education Organisations (incl. Universities)	5,165	5,600	7,000
Cultural Institutes (incl. Paedagogical Inst.)	2,337	2,900	1,956
Libraries	206	220	400
Total	**44,492**	**49,320**	**55,386**

Source: Hungarian Statistical Pocket Book '92, KSH

The Hungarian software industry is less successful in its own market which is slowly becoming the domain of outside software and services vendors, particularly for the sectors of packaged software for both PCs and multi-user systems, and professional services. The computerization of public administration and utilities has created a number of opportunities for Western software and services vendors, for both independent firms and the services units of major hardware suppliers. A number have been conducting project support in the country, providing application and organizational consulting.

3.5. IT Skills and Expertise

With an economy heavily dependent on foreign trade, Hungarian leaders have long considered a high level of computer literacy to be an integral part of the country's competitiveness in the international economy. Consequently, Hungary appears to have a better record than the other former CMEA countries in terms of computers applied in schools, universities and continuing education programs. The Hungarian government carried out extensive efforts to place IT equipment in education institutions during the early 1980s, launching an extensive computerization program designed to supply every school with at least one home computer. Consequently, almost every Hungarian school today has an IT lab, and personal computers are employed for computer science and training, as well as for the overall educational curriculum. The installed base of computers in this sector is illustrated in *Table 15.*

The country's long term emphasis on IT development is also reflected in the number of IT specialists trained on an annual basis in Hungary (see *Table 16).* Approximately 9-10,000 IT personnel are schooled each year, either as graduates from local universities and technical schools, or as individuals seeking certification for specific IT skills and studies. While some have turned to Hungarian IT companies such as Müszertechnika for further training, many rely upon the services of the research company Kopint-Datorg, or the state IT organization, SZAMALK, both of which provide a variety of career education programs in computing technology. As the largest international IT education organization in the Eastern European region, SZAMALK is said to train some 4,000 students per year. Hungary has also seen the emergence of special private schools for IT training such as the Gabor Denes Schools for Informatics.

Hungary has become well-known throughout the international IT industry for its superb software programmers and IT specialists. Indeed, *Table 17* illustrates that the country fields a relatively large number of well-educated software and computer science personnel, many of whom are university graduates of mathematics, statistics, engineering and informatics. Employing Hungarian software engineers has become an attractive option for many Western IT firms due their high qualifications at all programming levels (i.e. architecture/platforms and high level languages), as well as the low cost of Hungarian labour. Numerous IT experts from Hungary accept employment contracts from companies based in Western Europe. For example, an agreement signed in 1989 between the Hungarian and German governments enabled up to 2,500 Hungarian IT specialists to work in the German IT industry.

3.6. IT Market Outlook

Hungary's information technology hardware market is expected to grow at an annual rate of just under 10 percent in terms of value through 1995. Most vendor activity will be confined to the low end of the market, in particular to small-scale systems, Unix-based servers and workstations, personal computers, data communications hardware and office equipment items.

Market growth through 1995 will stem largely from three vertical markets: the evolving private sector, banking/financial services and government administration. Hungary has seen the number of private limited companies and registered traders mushroom over the last three years to 65,000 and 500,000 respectively. Many of these organizations will require basic levels of IT equipment, in particular PCs, printers, fax machines and copiers.

	1980	1990	1991	1992
Technical Directors	1,090	1,922	1,800	1,700
Systems Analysts	1,381	2,162	2,000	2,100
Process Analysts	1,073	1,395	1,400	1,000
Programmers	2,754	4,860	4,800	4,650
Technicians	1,547	1,730	1,800	1,700
Computer Center Operators	1,609	2,736	2,700	2,700
Data Entry Operators	4,156	5,979	5,900	5,900
Punch Card Operators	113	22	20	20
Table Readers	577	708	600	500
Coders	886	891	900	850
Other	2,854	5,034	4,280	5,380
Total	**18,040**	**27,439**	**26,200**	**26,500**

Table 17
Overview of IT Professionals in the Hungarian Computer Industry

Source: Hungarian Statistical Pocket Book '91, KSH; Hungarian Statistical Pocket Book '92, KSH

Hungary was the first country in Eastern Europe to recognize the importance of a modern banking infrastructure and to reform the primitive banking and financial system inherited from the centrally planned economy. The devolution of state control over the financial services industry has made this sector the most important and competitive in terms of IT vendor activity as banks seek to modernize basic infrastructures. Growth in the demand for computing technology is also a reflection of the mad rush of Hungarian banks to automate operations in the wake of potential competition from Western European banks. Moreover, it is one of the few vertical markets that has received significant financial support from the international lending community. The World Bank, for example, has granted Hungary a ECU 51 million credit to upgrade the country's financial services sector and create an electronic banking infrastructure. The European

Union has provided funding for computerizing and automating the Hungarian Stock Exchange and the Budapest Stock Exchange.

At least 20 additional medium-scale mainframes, 60 to 80 small-scale systems, and 10 to 15 thousand personal computers will be needed to complete the computerization of Hungary's banking, financial services and insurance sectors through 1994. Although many contracts have been awarded in the 1991-93 period, a number of organizations are still in the process of automating basic services.

Public administration represents another area of significant market growth potential in consideration of its generally low level of computerization. While no specific ministry is responsible for overall IT development, the Hungarian government has established an Interdepartmental Committee within the Prime Minister's Office whose role is twofold:

i. to identify strategic IT directions in compliance with standardization requirements in Europe, primarily those of the European Union, as a newer member of CEN, CENELEC ETSI and ETNO; and

ii. to supervise the development and application of a unified information system in central administration, based on an FDDI network. One of its most important tasks is to ensure that all systems installed in public administration are compatible and meet open systems standards. All ministries are obliged to design a computerization program in conjunction with the Committee.

The government is also venturing into the sphere of public data information systems and networks, having introduced a national Information Infrastructure Program for the development of country-wide networking capabilities to provide as many users as possible with access to database resources. Presently, only a few national government organizations utilize a large-scale data network, such as the Population Registration Office, HCSO, which operates an X.21 based network, and some public administration organs which are attached to private X.25 networks. Other organizations have begun to explore opportunities to establish public information databases. The State Audit Office Computer Corp. (ASZSZ) has founded the Hungarian Public Service Database (Magyar Közszolgalati Adattar) in association with several state administration bodies.

Aside from the traditional funding provided to local firms, particularly software organizations, the Hungarian government is offering direct assistance to the native IT industry by giving some preference to local PC manufacturers in official tenders. The most notable example is the tender awarded for the computerization of a section of the Ministry of Health and Social Services, the trade company OMKER. Despite competitively priced offers from name brand vendors, the first round contract was granted to a consortium of local firms. As one of the largest contracts to date in Hungary, it calls for the delivery and installation of 10,000 personal computers over a several year period.

Although a number of public tenders have been awarded over the last two years, it should be noted that the computerization of government administration will be a long term process, offering ample opportunities for IT vendors in the coming years. In fact, a number of identifiable opportunities for shipment activity still exist, particularly among governmental agencies, basic state records (social security, statistics, population records, legislation) and telecommunications. In 1993, for example, tenders will be awarded by the Hungarian Telecommunications Company for an Operation Support System (OSS), the National Health Service for the modernization of its IT infrastructure, the Hungarian National Police for the installation of computer systems and software, and the National Customs and Excise Office for a basic information system.

While company restructuring and privatization have undercut the financial ability of many local companies in manufacturing and industry to upgrade their current computing facilities, these sectors still embody significant potential. In fact, several large tenders are still outstanding in the sectors of energy and transportation. Additional funding and contracts will become available as Hungarian enterprises are sold off to their foreign counterparts, and as multinational companies continue to invest in the country. The shortage of investment capital among wholly-owned Hungarian firms in the manufacturing sector is limiting procurement to less expensive alternatives such as small-scale systems, personal computers and LANs.

4. Poland

4.1. Economic Development

After several years of economic decline and a deep recession, the Polish economy illustrated the first signs of economic stability in 1992 as GDP actually grew by 1 percent. This development is largely related to ongoing rises in industrial production, growing exports to the OECD countries, particularly the European Community, and the increasing importance of the private sector. Indeed, industrial production grew by 3.5 percent in 1992 and by more than 6 percent in the first half of 1993. The share of the private sector in overall GDP now comprises more than 50 percent compared to only 35 percent a few years ago. Total GDP is projected to grow by an additional 3 percent in 1993.

The Polish government was also successful in meeting its target of keeping the annualized rate of inflation to under 45 percent in 1992, despite significant increases at the start of the year due to a growing fiscal deficit, wage rises and a sharp rise in the prices for utilities and energy. Original

	1991	1992	1993*
Gross Domestic Product (Change %)	- 7.0	1.0	3.0
Industrial Production (Change %)	- 11.9	3.5	6.0
Share of Private Sector in GDP (%)	42	45	52
Consumer Price Index (Change %)	70	43	37
Unemployement Rate (%)	11.8	13.6	15.5
Exports to OECD Countries (US $ billion)	9.5	10.9	11.2
Imports from OECD Countries (US $ billion)	12.8	13.8	12.5
Current Account Balance (Million ECUs)	- 1,046	- 207	- 1,001
Registered Joint Ventures	4,796	8,860	12,800
Number of Private Companies (4.93)	44,226	59,002	61,437
Labour Force (million) 1.93:	18.3		
Population (million) 1.93:	37.9		
Total Foreign Investment (Billion ECUs) 12.92:	1.2		
Committed Downstream Investment (Billion ECUs) 9.93:	3.4		
Total Foreign Debt (Billion ECUs) 1.93:	35.8		

* EIU Estimates
Source: Economic Intelligence Unit, OECD, Business International, National Statistics

Table 18
Poland: Economic Indicators, 1991-93

Table 19
Value of the Computer Hardware Market in Poland, 1991-95 (Million ECUs)

	1991	1992	1993	1995	CAGR 1993-95 (%)
Multi-user Systems	28	39	43	51	
Personal Computers	105	168	184	235	
Workstations	2	6	9	17	
Printers	50	69	81	107	
Total	**185**	**282**	**317**	**410**	**13.7**

projections for single-digital inflation by the 1993-94 period now appear unrealistic in the face of a current account deficit, wage pressures and currency devaluation.

In 1990, the problem of unemployment appeared in Poland for the first time in country's post-war history. By April, more than 300,000 unemployed were registered out a total working population of 18.3 million. This figure rose to 2.2 million in 1991 for 11.4 percent of the workforce in the wake of company restructuring and privatization. The 2.5 million number recorded for 1992 is projected to increase to over 3 million, or 16 percent of the labor force, by year end 1993. Many of the newly unemployed have gone to the private sector which now accounts for over 58 percent of the actively working population.

Despite an increase in the level of foreign direct investment, it still remains insufficient to have a major impact on the country's overall economic development. The level of foreign investment grew to only ECU 1.23 billion in 1992, which is projected to increase to ECU 4.62 billion by 1994 in the face of a large number of recent purchase of Polish companies by outside investors, particularly in the automobile, steel, telecommunications, cement and paper industries. The number of joint venture firms continues to increase at a substantial rate with an anticipated figure exceeding 12,800 by year end 1993.

Poland was the only country in East Central Europe to post a current account deficit in 1992. This development continued in the first eight months of 1993 as Polish exports showed a four percent decrease while imports soared to produce a ECU 1.23 billion trade deficit. Figures from the Polish Central Statistical Office indicate that much of this figure stems from trade with the European Community which accounts for roughly 60 percent of imports and 50 percent of total exports. The Polish government is likely to devalue the zloty by an additional 10-15 percent by the end of the year to enhance the competitiveness of Polish exports. The zloty is currently depreciating at a rate of 11 zloty per day.

The 1991-93 period has been significant for Poland in its relations with the international lending community. In 1991, the Polish government asked its creditors for an 80 percent reduction in foreign debt, maintaining ongoing negotiations with the Club of Paris (group of creditors' governments - ECU 25.4 billion debt) and the Club of London (group of commercial banks - ECU 10 billion) over debt rescheduling. Arrangements with the Club of Paris produced an unprecedented multilateral deal in 1992 for reducing official hard currency debt by 50 percent in a two stage process: an immediate reduction by 30 percent, and a further 20 percent by 1994 conditioned upon meeting the objectives of an economic stabilization program mandated by the IMF. Negotiations are currently underway with the Club of London for a similar agreement, albeit at a level of only 30 percent. Poland's foreign debt reached almost ECU 36.2 billion in 1992, which is expected to increase slightly in 1993.

4.2. IT Hardware Market Development

The Polish market for IT hardware continued to exhibit strong growth in 1992, rising in value to over ECU 371 million, which marked a 55 percent increase over the previous calendar year (see Part Three, Statistical Outlook, Table 30). This country market is overwhelmingly oriented to PCs and related technologies which accounted for close to 64 percent of total IT hardware value. Sales of personal computers surged in Poland with shipments reaching an estimated 178,050 units for ECU 168 million, to make it the largest market among the smaller countries of the East Central European region. A similar position is maintained in the markets for printers, copiers and facsimile machines.

Several important economic developments took place in the 1991-93 period which fundamentally altered the dynamics of Poland's information technology market. They have also had a strong impact on vendor activities and the formulation of local market strategies. They can be summarized as follows:

Foreign trade and customs reform

One of the most important influences on the evolution of the IT market over the last two years has been foreign trade and customs reform. *Table 20* illustrates that customs reform actually began in January 1991, when the Polish government proposed to increase import duties on electrical components and computers to 20 percent. The local IT industry's negative reaction to the proposed policy, especially among local PC assemblers, was so emphatic that the Ministry of Foreign Trade was forced to revise policies several times.

Chronology of polish customs reform

1. Announcement of a 20 percent increase on import duties for personal computers, components and related items. (December 1991)

2. Temporary suspension of 20 percent customs duty proposal. (March 1991)

3. Compromise increase of 5 percent. (September 1991)

4. Reinstatement of the 20 percent duty regime in the wake of Poland's new status as an Associated Member of the European Community. (January 1992)

5. Duties redefined as applying to non-EC imports only. (March 1992)

6. Quota systems for PCs, components and electrical goods established. (January 1993)

In January 1993, IT vendors were given a respite from customs duties with the introduction of an import quota. The government's response to extensive local criticism of its trade policies was to establish a quota system, or contingent, for the import of information technology. In general, the policy provided for ECU 282 million in duty free imports of non-EU sourced PCs and components by local firms and name brand vendors. Over ECU 44 million of this figure was granted to the Committee of Scientific Research (KBN) and the Ministry of Industry (MP) for the import of name brand equipment. Moreover, ISO 9000 certified international vendors were to receive part of the quota automatically, as preferred suppliers of the Polish government's steering committee for IT. The remaining amount was to be distributed in allotments to local IT companies based on an estimate of their market share as well as the previous

Table 20
Program Data on Telecommunications Development in Poland

	1990	1995	2000
Lines	3.3	5.4	10.0
Waiting List (Phones/Years)	13	0.6	N/A
Main Lines/100 Inhabitants	8.3	13.2	30.0
Planned Telecom Investment 1991-95			ECU 1.46 Bn
Planned Cellular Comm. Subscribers 1991-95			200,000

Source: US Department of Commerce

year's sales and turnover. The decision to lift customs duties on certain commodities imported from EU countries also meant that suppliers were obliged to submit certificates of origin for the traded goods.

Aside from customs duties, the Polish government still required through July 1993 that all IT imports be subject to a special 6 percent border tax. Although the recently introduced value-added tax supplanted this levy, the Polish Parliament is in the process of reinstating the 6 percent rate, as a duty and a supplement to the VAT, in order to generate much needed revenues.

Value-added taxes

The IT market endured another shock in July 1993 as a new value-added taxes (VAT) were introduced by the government in order to widen the tax revenue base and harmonize Poland's taxation system with that of the European Union. The complex maze of duties and taxes to which IT imports are now subject can be summarized as follows:

i. Systems receive a 20 percent customs duty based on the CIF price, plus a 6 percent border tax, and a 22 percent VAT when sold. If the equipment falls under the quota regulation then only the 6 percent border tax and the 22 percent VAT are payable.

ii. Components are subject to a 14-17 percent customs duty based the CIF price, plus a 6 percent border tax, and a 22 percent VAT when sold. If the equipment falls under the quota regulation then only the 6 percent border tax and the 22 percent VAT are payed.

It is clear that companies which are able to ship their IT equipment into the market under the auspices of the quota have a decisive advantage over firms which must pay duties. The former, for example, may price PCs and components at 14 to 20 percent less than the latter.

Currency reform and market consolidation

Compounding the woes of local firms has been the ongoing devaluation of the Polish Zloty which has initiated a market consolidation among local IT firms that will continue through the 1993-94 period. Indeed, currency reform and international price competition have brought an abrupt end to the avariciousness of the sellers' market, producing a drastic reduction in prices and margins for office equipment items, and unleashing a price war at the low end of the market.

Falling margins are likely to cause a number of local companies to overleverage their equity positions, in particular those firms which are attempting to finance expansion through extensive borrowing from local banks. While the sellers' market which existed for most local IT vendors through 1991 allowed them to hedge anticipated profits against bank loans, frequently borrowed at commercial interest rates ranging up to 60 percent, declining prices and margins along with greater outside competition will jeopardize the creditworthiness of many assemblers and resellers. In fact, they will have to sell ever greater numbers of IT items to retain cash flows and profitability in a market which is becoming increasingly more competitive day by day.

4.3. Telecommunications

At the outset of 1993, Poland still retained one of the most underdeveloped telecommunications infrastructures in the East Central European region with a penetration rate of only 10.5 lines per 100 residents. The Polish government has recognized the importance of telecommunications modernization to the overall establishment of a market-based economy and has sought to implement a full-scale development program to devise a digital infrastructure capable of meeting the demand of 10 million new customers by the year 2000, or 30 lines per 100 capita. Estimates of the total investment required to meet this goal range from ECU 11.6 billion to ECU 15.4 billion, which make it quite ambitious when considering annual growth in GDP.

One of the government's first steps was to end the former Polish Post, Telegraph and Telephone Company's (PPTT) monopoly on telecommunications by restructuring the organization and inviting competition for the development of local, long-distance and international telephone services, as well as mobile and data services. Introduced in 1991, the Polish Telecommunications Act redefined the PPTT's operational and administrative functions by dissolving it into three separate business units covering postal, telecommunications and radio services. Two new companies were created, a state-owned State Public Utility Enterprise Polish Post Office (Poczta Polska), which provides postal services, and the joint stock company Telecommunication Poland (Telekomunikacja Polska S.A.-TP SA) which retains a monopoly over telecommunications development.

The Telecommunications Act also allowed for some privatization and decentralization of services, which produced a three tiered system distinguished by the level of TP SA's involvement. For example, the international toll network remains fully under the control of the TP SA, while domestic services may be provided by private operators. While the share of foreign capital in national toll facilities for the country's 49 regions may not exceed 49 percent, local networks may be fully owned and operated by private firms. As private operators are free to set their own rates, the Polish government retains the right to fix an upper limit for both public and private organizations. The Ministry of Communications also decreed in mid-1991 that each new system installed in the Polish network must be 50 percent Polish-made, which resulted in a flurry of activity by major telecommunications vendors to sign agreements with local manufacturers.

A number of concrete improvements were made in the 1990-92 period to develop the country's telecommunications infrastructure. A new international gateway switch was installed, and a satellite earth station and a digital microwave business network were established which more than doubled the number of international links. Other steps included the installation of a digital microwave overlay business network, Komertel, which offers a capacity for 2,000 subscribers, the development of a north-south NSL and east-west TEL light-pipe buses, the implementation of the Polkom E-mail service and the introduction of the national paging system, Polpage. Poland's first NMT 450 MHz analogue cellular network was also set up in Warsaw and eight other regional centres. It is to cover over 50 percent of the country by 1994. Finally, the number of subscribers was raised to over 4 million, with a total of over 372,000 new telephone installations in 1992 alone.

Strategic goals for the 1993-95 period include 500,000 to 600,000 additional subscribers, ongoing improvements in the quality of telecommunications, the development of new telephone

services and the creation of a standardized national long-distance trunk network within the country. Overall, the number of main lines is expected to increase to 5.4 million by 1995, or roughly one telephone for every seven people. The full digitalization of telecommunications is to ensue in 1993 once a system is selected, which will enable the TP SA to introduce new services through the so-called intelligent networks and ISDN. Digital expansion entails plans for new transit exchanges, digital radio relay links and fiber-optic links, all 140 Mbps. Moreover, the development of a West European-based GSM cellular radiotelephone system at 900 MHz band is reportedly planned for sometime in 1994.

Until a local ISDN network is fully established, most end-users requiring datacommunications services, e.g. organizations in banking/financial services, government administration and education/universities, rely upon one of three X.25 networks currently in operation, including Polpak, NASK and Telbank.

The planned investment of ECU 1.46 billion for telecommunications development through 1995 is being financed by a combination of loans from the international lending community, domestic loans and revenues of the TP SA. For example, funding in 1992 comprised ECU 434 million consisting of ECU 53 million in domestic loans, ECU 232 million in TP SA revenues and ECU 211 million in Western loans. Overall, the Ministry of Communications has been able to raise some ECU 462 million from Western government and commercial sources. For example, the World Bank approved a ECU 92 million loan to finance the digital network for improving international links. This funding is being co-financed by the European Investment Bank, which is providing ECU 69.3 million for 70,000 business telephones and improved services for 900,000 private subscribers. The EC's PHARE Program funded 40 percent or ECU 5 million of the costs of a 1992 experimental program to build and operate telecommunications networks in three Polish rural districts. The EBRD has loaned ECU 46.2 million to the Polska Telefonia Komorkowa (PTK), a joint venture cellular operator in Poland.

4.4. Software and Services

Western vendors control the greater part of the official software and services market in Poland which reached an estimated ECU 143 million in 1992. As the IT hardware market consists largely of PCs and related technologies, most software vendor activity is focused on sales of packaged software, customized applications development, networking and hardware/software support services.

Polish companies continue to play an important role in the software market in terms of distribution, education/training and customized application development. A number of smaller value-added resellers have ensured themselves a niche with the creation of software for a specific vertical market, platform or application. Others are focused on providing applications and support for the country's evolving Unix systems marketplace. Local Unix expertise can be found in a few large software houses and a number of smaller software organizations, the majority of which provide application development support for PCs and workstations, in particular for sectors such as banking.

The ongoing consolidation in the Polish PC market has also led a number of local companies to become involved in the emerging market for IT training and educational services. They offer full scale programs and coursework for skills development in Unix, networking and software programming. Some train 2,500 or more individuals annually.

While the gray market for software products is diminishing, software piracy is still widespread and rampant in Poland. Today, there is growing local concern over piracy as both international and Polish vendors are pressing demands for some form of legal protection of intellectual property rights. Several Western countries have also attempted to put political pressure on the Polish government to address the problem. In response to ongoing complaints, legislation has been introduced to give the country a copyright law which encompasses protection of computer software. In 1992, several Polish software companies and distributors for foreign vendors formed the Polish Software Market Association whose aim is to work closely with Polish authorities to develop software copyright laws.

4.5. IT Skills and Expertise

Poland traditionally lagged behind other East European countries, both in providing IT equipment to schools from state resources and in supporting information technology curriculum development. Nonetheless, limited investment was offset by the large number of PCs purchased by private individuals, and the emergence of a very active user community.

While computer science was first introduced into the national education curriculum as far back as 1974, study of the subject remained largely theoretical until 1985 when the government launched its first far reaching computer education program designed to improve the overall level of computer skills among the young. From 1985-1989, it introduced over 15,000 computers into local high schools, 95 percent of which were 8-bit microcomputers. By the end of 1990, approximately 500 out of the total of 900 schools and 3,500 secondary schools had fully equipped computer labs (8-bit machines and PCs), where basic programming and computer skills were being taught. As personal computers became more prevalent in the country, the 8-bit machines were handed over to grade schools. The program was coupled with a two year postgraduate training program in computer science for teachers.

The Polish Ministry of National Education and its Information Technology Division have responsibility for the implementation of information technology at schools and universities, including 29,000 organizations, 600,000 teachers and 6 million students. Aside from determining the procurement of IT for this sector, the Ministry oversees the development of IT educational programs, trains teachers and provides legal software for education institutions. The Ministry maintains eleven separate centres for IT training throughout the country, which have schooled over 30,000 teachers since 1989. The current installed base of 36,500 school and professional PCs are largely utilized for teaching basic computer skills.

Local IT firms have also been playing a key role in the training of IT professional since 1991. Several offer full scale training programs and coursework for skills development in Unix, networking, software programming, maintenance and PC utilization. Morover, a number of them are promoting the local knowledge of IT through seminars and technology conferences. Here, they have received help from the Office for Information Technology at the Bureau for the Council of Ministers (URM), which has become very active in sponsoring IT seminars.

At its current level of IT market development, Poland can rely upon a relatively large number of well-educated software and computer science

Table 21
Annual Number of Teachers Trained in Information Technology in Poland, 1992

Year	Number
1989	3,900
1990	4,000
1991	5,000
1992	9,800
1993	11,000

Source: Polish Ministry of National Education

Table 22
Graduates of Informatics and Related Studies in Poland, 1992-93

Organisation	Number
Universities	
Informatics and Econometrics	157
Physics	242
Informatics	90
Mathematics	554
Technical Universities	
Automatisation	72
Electronics and Telecommunications	768
Informatics	340
Mathematics	46
Agricultural Academies	
Electronics	46
Mathematics	24
Economy Academies	
Informatics and Econometrics	225
Mathematics	344
Total	2,908

specialists, most of whom are university graduates of mathematics and physics, or the electronics departments of colleges of technology (see *Table 22*). Nonetheless, their expertise and skills are oftentimes underutilized, and most are underpaid by Western standards. Consequently, the brokering of IT labour has become a significant business in the country. Numerous local IT experts accept employment contracts each year with firms in the United States or Western Europe.

4.6. IT Market Outlook

Poland's information technology hardware market will continue to develop rapidly in the years ahead, with a projected growth rate of 13 percent through 1995 in terms of value. Although high growth rates exist for high-end mainframe equipment, most shipment activity will take place at the low end of the market, particularly for small-scale systems (proprietary systems, Unix-based machines, network servers, and client server technology), personal computers, datacommunications hardware and other office equipment items.

Poland's fast growing private sector, now numbering over 61,000 new companies and some 1.6 private traders, will serve as the primary source of IT market growth in the years ahead, in particular smaller companies employing from 10 and 200 people. The high number of private firms to personal computers, printers, copiers and fax machines installed indicates that many companies are still holding off on purchases of IT equipment. Moreover, the ongoing restructuring of public sector administration will spur the demand for all types of IT equipment. A number of state organizations and agencies are still not sufficiently equipped with IT equipment and constitute a potentially large market. Other

opportunities are entailed in the sectors for education, banking, financial services, insurance, education and manufacturing. Increased demand from private end users can also be expected as evidenced by increase sales of office equipment items into the home consumer market in the 1992-93 period.

Banking and financial services continues to be the most buoyant sector of the Polish IT market, accounting for a large part of multi-user, PC, networking and services activities. Indeed, the strong growth in the IT market seen in the 1991-93 period is in part a reflection of efforts to upgrade the operations and services of the country's banking system with information technology. It is also one of the few vertical markets that has received significant financial support from the international lending community, which is playing a key role as a source of investment capital for the procurement of computers and related telecommunications equipment.

The modernization of the country's banking structure is now, and will be, a prodigious undertaking, as it is extremely underdeveloped: just 30 bank branches serve Warsaw's 1.8 million people, while in comparison, 350 branches serve Vienna's 1.5 million people. Moreover, some bank branches in Warsaw handle 100,000 accounts, more than 20 times the number in many Western banks.

The greatest obstacle to the reform of banking and financial services has been the technological backwardness and lack of computerization in Polish banks. Whereas most banks throughout the world are utilizing modern information technology to process transactions, Polish banks still rely largely upon letters and telegrams. In fact, while the number of local banks has now grown to over 3,500, no more than 20 percent are computerized, according to some government sources. The most common form of money transfer among banks in Poland today is still via telegraph.

The first round in the computerization of the country's banking and financial services industry entails modernizing the range of banking infrastructure technologies, including back office host systems, front office branch automation systems, international banking operations, and specialized services including ATMs, POS and card management. On account of limited funding, Polish banking authorites have developed priorities of computerization. In effect, this means that systems designed for "front room operations", such as branch automation and teller machines, and "backroom operations", such as those for clearing checks and other transactions, are to receive the lion's share of funding in the near term.

Nonetheless, it should be noted that several problems continue to undermine vendor activity in this sector. In fact, many highly publicized contracts have encountered significant delays, due largely to problems with telecommunications. Few ATM networks are fully functional in Poland, and many branch automation systems are not yet operational. Moreover, the absence of banking business strategies, inefficient in-house accounting systems, and ongoing changes in banking legislation have prevented many banks from employing new equipment efficiently and effectively.

One of the most important growth sectors for information technology in the coming years will be government administration in consideration of its low level of computerization. Central and local administration, public utilities, and public financial institutions are still largely paper-based organizations with insufficient IT infrastructures. Those administrative organs which do possess IT technology generally employ stand-alone or networked, no-name personal computers, or low-end small-scale systems, due largely to the dictates of governmental procurement programs of the past. Presently, the only public information system integrated on a national level is PESEL, the government's program for record keeping.

Despite the uncertainties surrounding the ongoing reform of government administration, which has up to now discouraged the undertaking of large IT projects, the lack of computerization and integrated communications facilities at this level will lead to several opportunities for large systems integration contracts in the future. The Office for Information Technology at the Bureau for the Council of Ministers (URM) already estimates that total IT spending by the central government will exceed ECU 308 million in 1993, which is expected to increase to over ECU 385 million for the following year. Moreover, additional spending is anticipated from local organizations, such as the 15,000 gmina, the small administrative units whose budgets for IT expenditures are independent of the resources of the central government. They are expected to spend on the average more than ECU 77,000 annually on information technology.

The computerization of the public sector can be divided into three administrative and geographical levels depending on the type of government jurisdiction: national administrative units, local districts (voivodships), and municipal organizations called gmina. Priority is initially being given to the computerization of central organizations. Current projects in this sector can be divided according to the following groups:

Group 1: Group 1 entails government bodies where significant progress has already been made in terms of awarding tenders and revitalizing IT infrastructures. Projects with the following organizations have either been finished or are close to completion: Offices of the Senate and the President, the National Election Bureau (KBW), the URM, the Ministry of Internal Affairs, Ministry of Industry and Trade, Ministry of Health Care, Committee of National Research (KBN), Ministry of Privatization (MPW), Ministry of Transportation, GUS, National School of Public Administration, national administration court.

Group 2: Group 2 incorporates a number of IT projects in government administration which are in the implementation stage. They include Poltax, an information system for National Police and Border Troops (Ministry of Internal Affairs), the computerization of the universities and scientific institutes coordinated by KBN, the computerization of association of voivodships, and additional computerization of the KBW.

Group 3: The last group contains a large number of public sector computerization projects which are currently being proposed and evaluated by the IT Bureau of the URM. Organizations with projects at this stage include the National Security Office, the Chamber of Parliament, the document archives of the URM, employment offices of the Ministry of Labor (World Bank sponsor), ZUS, KRUS, Central Customs Office, Department of Transportation and Marine Industry, Ministry of Health, central election bureau, central statistical bureau GUS, and the Polish EPA.

Several official organizations are now closely involved in the computerization of the public sector in an attempt to determine requirements, to devise local IT specifications, and to provide some guidelines for reviewing vendor offers. Much of their activity is focused on devising procedures for IT development and procurement at both regional and national administration levels, which conform to EU standards. Poland's agreement with the Union stipulates that most of these changes will have to be made within a certain timeframe, which places added pressure on the Polish government to make IT improvements. One early implication of the agreement is the overhaul of the Polish fiscal system by the Ministry of Finance, resulting in a totally new personal, income and value added tax structure, accompanied by the development of a new IT infrastructure, Poltax.

Despite the widespread need for IT replacement and upgrading in industry and manufacturing, the shortage of investment capital and the ongoing recession in industry are limiting procurement to less expensive alternatives, such as small-scale systems, personal computers and LANs. Poland's manufacturing sector has been particularly hard hit by the government's austerity program. With industrial production falling by over 35 percent over the last three years, most enterprises in this sector have been undertaking minimal new investment in information technology.

Among the major difficulties facing this sector are the widespread uncertainty associated with the privatization process, which has undermined IT expenditures, as well as cuts in public subsidies. According to industry officials, the confusion surrounding privatization sector has resulted in widespread concern about the effectiveness of the process as well as its timetable. It has also limited the ability of enterprise managers to make decisions and implement new IT strategies, which has been instrumental in producing a downward spiral in spending on computing technology in industry.

Industry and manufacturing may provide IT vendors with new opportunities once newly independent, financially solvent companies evolve, as evidenced by the shipment activity of several IT vendors in 1992. There were a number of subsectors of industry which purchased IT equipment over the last year, including areas such as energy companies, the fuel industries and textile manufacturers. Moreover, funding and contracts is becoming available as Polish firms are sold off to their foreign counterparts, and additional large-scale investment projects in industry are implemented.

5. Former Soviet Union

5.1. Economic Development

The new countries comprising the *Commonwealth of Independent States* are confronted by an interrelated set of severe economic problems consisting of falling GDP, burgeoning inflation, unstable currencies, rising unemployment, declining trade, growing foreign debt and a sharp drop in the standard of living for the average citizen. The vagaries of economic and political reform and ethnic conflict have impacted differently on the various CIS states with strife-ridden Georgia, Armenia and Tajikistan seeing the sharpest contractions in output and GDP, while Turkmenistan and Uzbekistan saw little change, based on official estimates.

In the largest republic, the *Russian Federation,* real GDP fell by almost 20 percent in 1992 in the wake of a collapse of intra-regional trade and a decline of 24 percent in productivity, particularly in the energy and mining industries and sectors dependent upon imported raw materials and

Table 23
Sample CIS & Baltic States: Economic Indicators

		1991	1992	1993*
Gross Domestic Product (Change %)				
Russia		- 9	- 19	- 10
Ukraine		- 11	- 18	- 25
Estonia		- 11.0	- 26.0	- 8.0
Latvia		- 8.0	- 33.0	- 17.0
Lithuania		- 13.4	- 35.0	- 12.0
Industrial Production (Change %)				
Russia		- 7.3	- 24	- 10
Ukraine		- 10	- 10	- 30
Estonia		- 13	- 39	- 3
Latvia		0	- 35	- 5
Lithuania		- 18	- 52	- 5
Consumer Price Index (Change %)				
Russia		90	2,510	2,000
Ukraine		450	2,500	4,000
Estonia		211	1,069	80
Latvia		172	951	100
Lithuania		216	1,020	380
Labor Force (million) 1.93:				
Russia	Ukraine	N/A		
	Estonia	0.78		
	Latvia	1.49		
	Lithuania	1.87		
Population (million) 1.93				
Russia	Ukraine	52.3		
	Estonia	1.56		
	Latvia	2.58		
	Lithuania	3.76		

* Forecast
Source: Economic Intelligence Unit

components. Inflation also soared to 2,500 percent in the face of price liberalization, wage rises and uncontrolled growth in the money supply. While Russia has taken responsibility for repaying the former Soviet Union's ECU 61.6 billion in foreign debt, it has consistently defaulted on payments to both commericial and official creditors in the 1992-93 period. The only bright spot of the economy is the unemployment rate which stood at less than 1 percent according to official statistics. In 1993, the country's performance will be worse than originally forecast due to political instability and substantial delays in the economic reform process. While the current Russian government is fully committed to the introduction of a market economy, it faces considerable resistance on the part of industry, conservative political parties and large a section of the population.

Similarly, the second largest economy of the CIS, the *Ukraine,* is presently in a deep economic recession with overall GDP projected to decline by 25 percent in 1993 after an 18 percent fall the previous year. A large fiscal deficit and an uncontrolled money supply also threaten to push the annualized inflation rate to 3,000 percent in 1993. In addition, the country has seen a sharp decline in foreign trade and a shortage of hard currency reserves. The Ukraine has limited access to commercial finance due the ongoing dispute with the Russian Republic over the legacy of Soviet debt. Despite economic decline and the widespread uncertainty surrounding reform and privatization, the country remains an attractive market for outside investors in view of the size of its population and economic potential.

Traditionally more developed than the other republics of the former Soviet Union, the *Baltic States* are in a better position weather the transition to market economies, particularly with the support of the Scandinavian states. Nonetheless, the long-term dependency on Russian trade and energy continues to impact heavily on overall economic development. GDP contracted sharply in all three countries in the 1992, with the largest decline taking place in Lithuania. Inflation also skyrocketed last year averaging close to 1,000 percent per country. All three economies appear to have stabilized somewhat in 1993 with projections of lower inflation and smaller decreases in GDP and industrial production. Outside firms are still reluctant to invest heavily in the Baltic States due insufficient economic regulations and the potential for ethnic conflict. Estonia remains the most popular site among the three countries: over 4,000 joint ventures are registered, and total investment increased to ECU 385 million by August 1993.

5.2. IT Hardware Market Development

While the markets of the CIS and Baltic States represent the most challenging for IT vendors, they also embody the largest single opportunity for IT market development in the world today. Indeed, the sheer size of this combined market and the dearth of computing technology will drive substantial market growth through the year 2000, despite the dire state of the region's economies. Although the regional IT hardware market contracted by more than 44 percent in 1992, it has resumed its course of rapid development in the 1993-94 period and it is projected to increase to more than ECU 1,187 million by 1995 (see Part Three, Statistical Outlook, Table 31).

	1991	1992	1993	1995	CAGR 1993-95 (%)
Multi-user Systems	208	26	55	190	
Personal Computers	312	199	304	586	
Workstations	5	6	22	40	
Printers	65	58	92	177	
Total	**592**	**290**	**474**	**993**	**44.8***

Table 24
Value of the Computer Hardware Market in the Former Soviet Union, 1991-95 (Million ECUs)

Most IT vendor activity remains concentrated in the larger and more lucrative markets of Russia, the Ukraine, the Baltic States, the Russian Far East and more recently Kazakhstan. Political and ethnic strife in smaller countries such as Georgia and Armenia have brought activity in their IT markets to a virtual standstill, although some companies continue to do business. While the level of computerization is quite high in the Baltic States, with an estimated 1,300 multi-user systems installed through 1991, the IT hardware markets are now primarily limited to minor shipments of PCs, printers and office equipment. For example, data from the Estonian Customs Department indicates that roughly ECU 4.23 million in computers was imported into the country in 1992.

Establishing a presence in the CIS and the Baltic States is a proposition which entails significant risk with little promise of short-term returns. It calls for significant flexibility and creativity on the part of IT vendors. The ineffectiveness of the CIS organization, the geographic expanse of these markets, the collapse of intra-Republican trade, and ongoing changes in tax

and customs regulations have led most IT vendors to redevise strategies and operations several times. The market can now be divided into several distinct groupings including the Baltic States, the Russian Republic, Belarus, the Ukraine, the Caucasus and Central Asia. While the Baltic States are generally covered from Scandinavia through local distributors and resellers, major international IT companies have either set up a direct presence in the more economically viable markets of Russia and the Ukraine, or in the case of software vendors, decided upon several local distributors. Operations for Central Asia and the Caucasus are generally directed from the Russian Republic.

The dismantling of the state's monopoly over IT distribution channels in the wake of the Soviet Union's collapse has fundamentally altered sourcing, distribution and marketing arrangements in the region. The channel disintegration which ensued in 1991 can be characterized by several distinct developments:

i. the disappearance of state channels has moved FTOs, state enterprises and private firms to initiate assembly and sourcing through gray and black market channels;

ii. channel development has been compromised by commodity exchanges and black market selling;

iii. international vendors have attempted to sign on local distributors, dealers and value-added resellers;

iv. the introduction of franchise resellers/ distributors into the domestic market.

IT distribution channels in the CIS and Baltic States are not as sophisticated as in other countries of the region, reaching only the initial stage in the transition to the type of structure found in Western markets. Nonetheless, this does not deter their complexity, as economic, political and practical concerns such as communications and transportion continue to make these markets some of the most challenging in terms of simple distribution logistics.

Ongoing changes in customs duties and import taxes remain a key problem for IT vendors in these markets, with practically each fielding a separate regime. While the Baltic States have instituted a flat 15-18 percent VAT as well as duties of 10-15 percent on imports of IT equipment, Russia and the Ukraine have introduced a more costly maze of import and tax regulations which has led to sharp price increases. Russia has placed a 15 percent tariff on finished products and 5 percent for components, in addition to a standard 25 percent VAT rate for all IT equipment. VAT in the Ukraine is also quite high at 28 percent. Moreover, the Russian government decreed in July 1993 that all IT hardware suppliers are required to receive a safety certificate approved by the Russian standards committee (Gosstandard). Goods imported with an existing foreign safety certificate must first have it approved by the Russian center of test and certification, Rostest. The certification process has added an additional levy of 0.1 percent on all imported IT equipment.

Amid growing confusion over the economic stability of the CIS countries, some IT firms have formed associations in order to share marketing information and formulate strategies to further their collective aims in the wider political context. Such organizations may be quite helpful to international IT vendors as they seek out potential partners as part of a market entry strategy. They include the "Association of Distributors of Computer Equipment" (ADCE), the Software Marketing Association (SMA), a software organization called "Informatika", and the International Computer Club (ICC), each representing various manufacturers, hardware vendors, software companies, developers and distributors.

5.3. Telecommunications

Despite several high-profile government initiatives in the mid-1980s to upgrade telecommunications infrastructure, the republics of the former Soviet Union preside over one of the most antiquated and underdeveloped systems in the region. Line penetration rates in the CIS vary by country with an estimated 16 for Russia, 14 for the Ukraine and less than 8 on average for the Central Asian states. Much of the switching equipment is over 40 years old, manual exchanges are used in many rural areas, and some 360,000 villages are without any phone service at all.

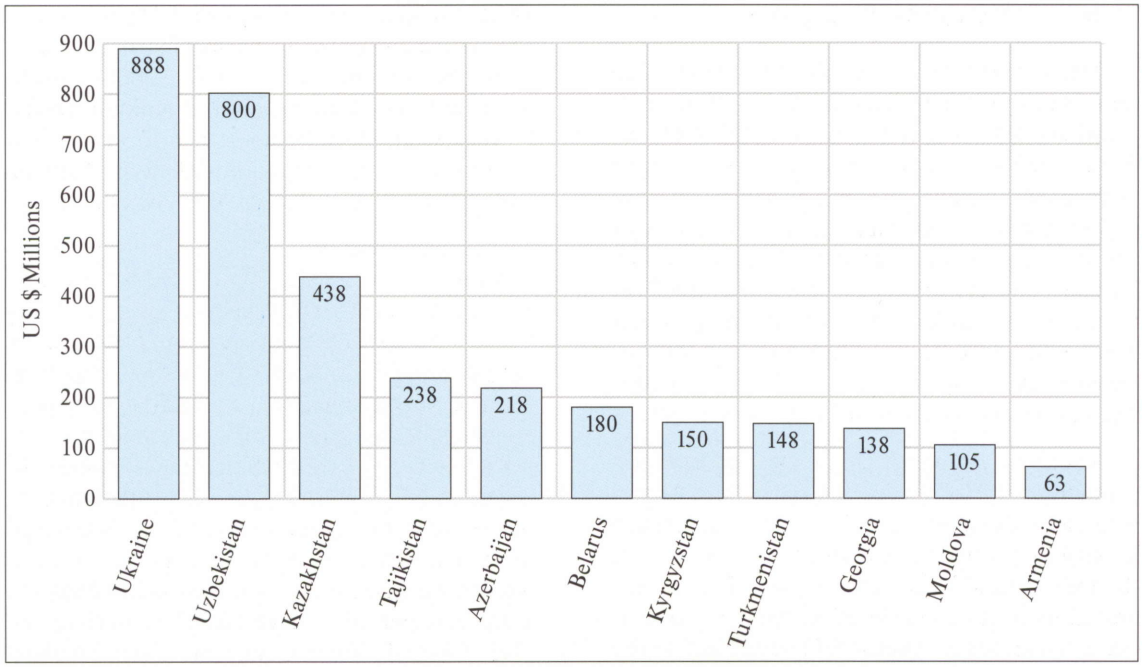
There were roughly 20 branch telecommunications networks in the former Soviet Union prior to 1991, many of which were controlled by specific ministries or organizations such as the military and secret police. This figure proliferated with the collapse of centralized government structures in August 1991, which led to the transformation of local republican telecommunications organizations into national units. The Ministry of Posts and Telecommunications of the Soviet Union (Minsviaz), which formerly held a monopoly over most telephone lines, voice and data services in the country, became the public authority for the Russian Federation only.

Although a regional successor to the Ministry, called the Regional Coordination Committee (RCC), has sought to establish a collective CIS policy and standards on telecommunications, most countries are pursuing their own developmental strategies and regulatory polices. For example, no country-wide strategy exists for the *Russian Republic* whose telecommunications system has become wholly decentralized and fragmented. With an open attitude to competition in order to attract investment, Minsviaz's various operating units are devolving into semi-independent organizations such as Rostel, which oversees data and value-added services nationwide, and Intertelecom, which handles long-distance, intercity telephone services. There are also regional and city companies linked to Minsviaz which provide local services and switching.

Minsviaz has also allowed a number of its operating units to enter into joint ventures or be privatized, particularly for data services, cellular communications and telecommunications equipment manufacturing. Several organizations have emerged in the Russian Republic which provide basic communications services such as voice, data, e-mail and international calling. A number of analogue cellular systems are in operation in the region all of which are based joint ventures between Western firms and local telecoms organizations. The network in Moscow alone is expected to have 60,000 subscribers by 1995. Several Western vendors have invested in the Russian telecommunication industry for production and distribution, working with such organizations as Minsviaz's scientific research arm, Krasnaya Zarya, which is to manufacture digital phone exchanges.

Telecommunications development within the CIS is currently focused on the establishment of international gateways, overlay networks, mobile cellular communications and additional lines for urban and rural areas. International gateways from capital cities such as Minsk and Kiev have become important signs of national sovereignty as the various CIS republics were formerly forced to rely upon a few gateways via Moscow for international traffic. Current plans

Figure 6
Annual Expenditure Required to Reach 30 Main Lines per 100 Inhabitants by the Year 2005



Source: ITU, OECD

for line development throughout the CIS region call for an increase from 40 million to 100 million by the year 2005.

The *Ukraine* has embarked on its own long-term program to upgrade its telecommunications infrastructure. In 1993, the country announced plans to invest UKR 1.2 billion and ECU 1.15 billion in telecommunications system through the year 2005. Major points of the program are the expansion of international and national lines, cellular networks, electronic data services and basic services such as videotext. The current infrastructure of 7 million lines is to be expanded to more than 13 million during this time period. Unlike most other Republics, the Ukraine intends to rely upon local financial resources and expertise to complete the program.

Near term plans included ECU 131 million investment for long-distance international exchanges, fiber optic cables running from the capital to Krakow and Palermo, cellular networks, a paging system for Kiev, and additional telegraph and telex stations. All major urban centers are to have new exchanges in 1996 with full digitalization foreseen by the year 2000. An X.25 network called Ukrpak should also be in operation in all larger cities by 1995.

Although the Ukraine will retain the state's monopoly on telecoms regulations and services, it is seeking outside support for areas such as cellular communications development and equipment manufacturing. To this end, the government signed a 20 year licensing agreement with the Danish National PTT to install a mobile telecommunications network on the NMT standard.

Seventeen regional Ukrainian telecoms organizations own 51 percent of the venture with the remaining 49 percent divided among several Western carriers. The NMT 450 MHz network is now in operation with coverage extended to Kiev and 20 major urban and transportation centers.

Another potentially lucrative market is *Central Asia*. Several former Republics with extensive natural resources and growing hard currency reserves are planning far-reaching programs for telecoms development. For example, Kazakhstan is aiming to invest an estimated ECU 1.92 billion through 2005 on public switching, transmission technologies, cabling, data and mobile communications and other equipment. It has already awarded contracts for a cellular network and the installation of 1 million additional digital-based lines.

Despite severe economic deterioriation and payments difficulties, the CIS represents a fertile market for telecommunications growth, as evidenced by the large number of vendors which have now taken up operations in this region. *Figure 6* illustrates the annual expenditure required to reach 30 main lines per 100 inhabitants by the year 2005. The total required funding for telecommunications development in the CIS is estimated to exceed ECU 77 billion. While most projects are to be financed through local resources and revenues, particularly in Russia and the Ukraine, some funding is to come from the international lending community. For example, the EBRD has already loaned ECU 4.85 million to Sovintel for the establishment of a digital system in Moscow, while providing ECU 32.8 million to Belarus for general telecom development.

The *Baltic States* traditionally retained higher line penetration than other republics of the former Soviet Union with roughly 22 lines per 100 inhabitants. They also played an important role as equipment providers for the rest of the region. For example, one of the most important industrial complexes in Latvia was the VEF Combine in Riga, which produced and exported telephones, radio communications and switching devices to other republics.

Telecoms development among the Baltic States today is closely linked to economic support from the Scandinavian states. All three countries have reached agreements with either the Swedish or Finnish PTTs for investment and technological support. For example, the Estonian government is involved in a joint venture with the Swedish and Finnish PTTs called the Estonian Telephone Company. With an initial investment of ECU 264 million and an 8 year monopoly, the venture will attempt to bring the country's telecommunications network up to Western standards by the year 2000. Plans call for the installation of 40,000 digital phone lines in the 1992-93 period, with 40,000 additional units each year thereafter. Several fibre optic cables are also to be laid including one to augment the existing 50 mile radio microwave link between Tallin and Helsinki, and a connection running from Tallin-Riga and Visby (Gotland) in Sweden.

Similarly, the Lithuanian government established a joint venture with the Swedish PTT in 1991 called JV Lattelcom, with an intitial investment of ECU 132 million. The venture is seeking to modernize the Lithuanian telephone network, having planned 75,000 new lines through 1992. Also foreseen are the construction of fibre optic and radiowave networks to be integrated.

Lietuvos Telekomas in Latvia is making a push for cellular communications with the joint venture company, Latvian Mobile Telephone. It plans ECU 7.7 million in investment over the next five years for the development both 450 and 900 MHz networks. Latvia was also the first Baltic State to receive membership in the European GSM. It is also involved in the establishment of a "Baltic Cable" which is designated for a number of cities throughout the region.

5.4. Software and Services

The software and services market in the former Soviet Union is largely a local one for reasons of price. While a number of Western software vendors have entered this market, total sales of legal packaged software for personal computers reached only an ECU 1.92 million in 1992 out of a total software and services market estimated at ECU 532 million.

The limited penetration by outside firms is a reflection of the extensive black market for pirated software and the large pool of local programmers. The Russian Republic has probably gone the furthest among the CIS states in its efforts to combat software piracy, which some estimates place at 98 percent or more of the market. In 1992, the Russian government introduced the "Law on Computer Program and Database Legal Protection" along with several decrees on patents and trademarks to establish the legal basis for the protection of intellectual property.

With over 300,000 software programmers and engineers in the CIS and Baltic States, much of the software utilized on PCs and multi-user systems is developed locally. The large number of IT software specialists will facilitate strong growth in the demand for application development tools, in particular relational database management systems and independent 4GLs. Other sectors which can be expected to see strong growth through 1995 include Unix, networking services, professional services and dataprocessing services. The centrally planned economy's legacy of outsourcing support from government, regional and enterprise dataprocessing centres still represents an important feature of this regional market.

5.5. IT Skills and Expertise

Educational computing in the former Soviet Union first received a great deal of attention in the mid-1980s. A Politburo decision in 1985 attempted to foster computer literacy in the general population through the creation of a secondary school program in Information Science to be completed by 1 million students through the year 2000. The widely heralded decree foresaw the training of several hundred thousand computer science teachers, as well as the installation of over 1 million microcomputers in the education system's 60,000 schools by the end of the 1980s. Moreover, a computer use course entitled "The Basics of Informatics and Computer Technology" was introduced throughout the secondary school system in the 1985-86 school year, which every 9th and 10th grader was required to attend. Course curriculum placed a major emphasis on the development of programming skills.

While the program was successful in generating greater interest in IT, it failed its original purpose of providing hands on experience to a substantial number of youth. In fact, the reality of the

1986-90 five-year plan was that the millions of systems intended to foster growth and familiarity with IT and microcomputing technology were simply unavailable. In fact the production of school and general purpose computers consistently fell below planned targets with the result that only 61,800 computers were available for the program's 4.6 million students.

In contrast to the overall lack of practical experience with IT are the renowned capabilities of students and researchers in the pure disciplines of mathematics, physics and engineering at the university level. The former Soviet Union matriculated twice as many engineers annually as the United States. Moreover, roughly 50 percent of all graduates in higher education throughout the 1980s were from science and technology fields, with the total number of scientists reaching 1.8 million by 1988. As the education system traditionally offered no major in programming or informatics, most of the country's IT specialists stem from one of these theoretical fields.

The general limitations of locally manufactured hardware and a university IT curriculum oriented on basic engineering and developing programming skills had the benefit of creating a local pool of highly qualified software professionals, which numbered 300,000 at the end of 1990. A number of hardware and software vendors in the West are now seeking to capitalize on this talent, bringing programmers to the United States and Western Europe, or establishing research organizations in the CIS. Aside from software programming, Russian scientists and engineers are involved in IT projects for fundamental research in semiconductor physics, microprocessor technology and networking communications.

While skills in the fundamentals of information technology are fairly common, the number of trained indigenous personnel with practical IT experience is limited. This is important for IT vendors entering the CIS market because it suggests that local employees will generally possess strengths in research and development, yet limited practical experience and management skills. While companies may initially draw upon resources in local research institutes and universities, serious efforts at training personnel to maintain and employ IT equipment will have to be undertaken. Some training and education centres are being established, albeit at a slow pace due to limited financing. Usually, companies must sponsor individuals in order to pay for the wordprocessing and database training.

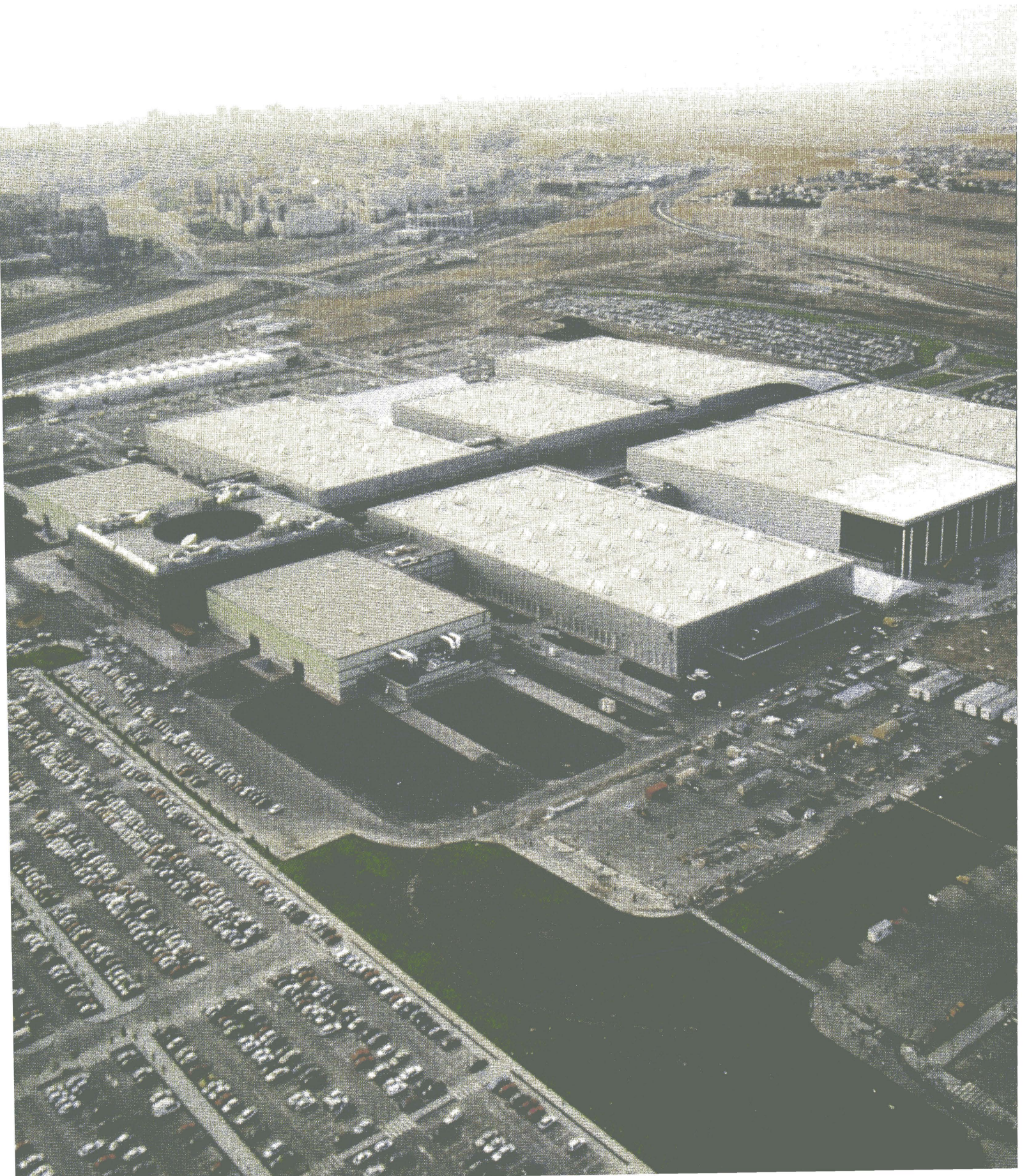
5.6. IT Market Outlook

There is considerable pent-up demand for information technology throughout the CIS and Baltic States. This combined regional market will exhibit one of the highest IT hardware growth rates in the world from 1993 to 1995 at roughly 42 percent. Much of the projected growth is a reflection of the low installed base of IT equipment of all types, as well as the sharp market contraction which occurred in the 1991-92 period. As in the countries of Eastern Europe, the evolving CIS and Baltic State markets will be overwhelmingly oriented to personal computers and related technologies in the first stage of computerization due to concerns over price. Substantial growth in the office equipment markets can also be anticipated.

Each individual country of the CIS and Baltics will need to develop IT systems for the basic tasks of collecting revenue, measuring economic activity and distributing benefits. In the short term, the most important sectors of IT market growth are represented by financial services, government administration (statistics, tax/customs, revenue collection and central bank operations), basic infrastructure (energy and transportation), social security systems, and other vertical markets such as industry and manufacturing.

The region's evolving banking industry is clearly the most lucrative sector in the short term. With significant hard currency profits, banks are the only organizations which are procuring more expensive, sophisticated hardware and software solutions. At the outset of 1992, the Russian Republic alone presided over 1,270 commercial banks with approximately 2,300 branches, a state Savings Bank with 42,600 outlets, and a Central Bank with 80 locations throughout the country. The vast majority of them are wholly undercomputerized with IT infrastructures generally limited to a few personal computers and corresponding software. Other important recipients of computing technology in the financial services include the many exchanges now in operation in the region.

Large-scale IT investment projects are also taking place in some areas of government administration throughout the countries of the region. In particular, the Russian government has recently invested in equipment for its Customs Committee, the President's Office, as well as several Ministries involved in communications and energy.



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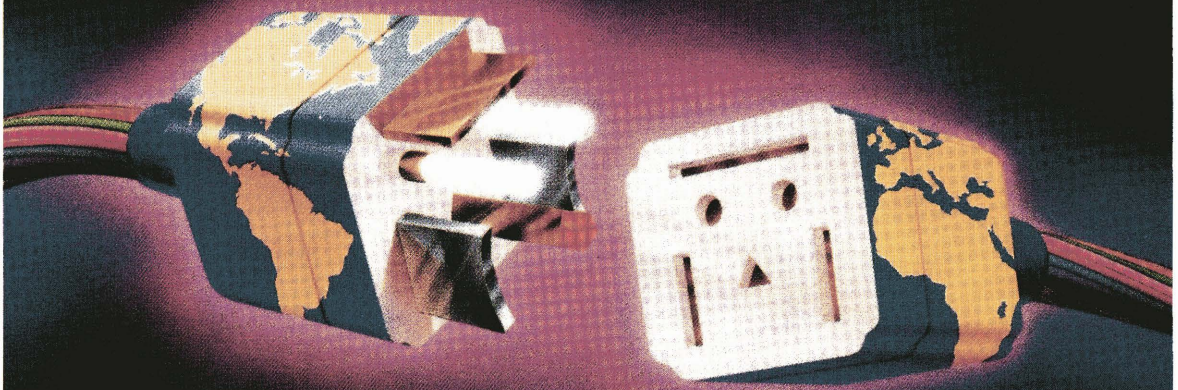

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PARQUE FERIAL JUAN CARLOS I MADRID

IFEMA

Mobile Computing and Communications in Europe: Towards a Digital Wireless World

This paper has been provided by Dataquest Europe in close cooperation with the EITO Task Force.

Modern man is not only a traveller but a communicator too, and the need to communicate increases the more he moves. This has lead to the demand for the telephone and the large telecommunications networks, painstakingly constructed over the last century, whose tentacles reach to the furthest corners of a continent. It has led to the growth of the notebook computer and the emerging melding of telecommunications and computing industries. In this section we'll look at:

- the background demographics and culture changes;
- the current state of affairs;
- the likely competition in the future;
- the future of the markets and the likely barriers to progress.

1. The Mobile Society

1.1. Demography

At any one time in Europe, the number of people in transit and on the move between their place of work and their homes, as part of their work, or in the course of pursuing their everyday lives is virtually impossible to count. In the UK for example, it is estimated that more than 95% of the adult population is transported by car in any week while cars account for 85% of all domestic passenger transport. At the same time many millions more travel on public transport, on the roads, in the air and by rail. If we look at business travel just in the UK, we see that businessmen make around 5 million journeys outside the UK, and spend over 2 billion ECU in doing so. If those figures are multiplied across the whole of Europe, then it can be seen almost beyond doubt that modern man is as much a nomad as his ancestors of long ago.

Not only is our mobile society faced with an increasing need to communicate but the speed with which it travels has increased the need for speedy communications. No longer can a message wait for half a day or even a few hours for a traveller to arrive at his destination before it is delivered. It must be instant.

Telecommunications strategies have therefore evolved to allow individuals to be found when they are on the move, either in transit or at fixed points during their journey. Initially these were simply a means of sending an indication that a message was waiting and that the traveller should make contact. In recent years, effort has been devoted to actually passing the message, and at the same time allowing an interactive conversation to take place.

The objective for most business people of communicating while away from a fixed physical location is to increase productivity. To use the otherwise unproductive travelling time to continue their business and work, and for this they need access to information that they cannot physically carry with them, or cannot predict

that they will need. They have a need not only for the sound of a friendly human voice, but to gather and pass information from their home base or to customers.

For these travelling business people, the ability to carry out data communications from portable terminal equipment provides an opportunity while in a different location to continue the work they would normally carry out in their office. This will only work, however, if they have easy access to all their corporate and office data bases through communications network.

For another group of workers mobile data communications provides a connection to their company's databases of which they previously were unable to take advantage. These are the workers in any organisation who by definition do not use desks in the normal course of the occupation. Their normal place of work may be in a customer's office or their own company's warehouse or factory, or in a delivery van.

The speed with which the information is processed can be vital in giving their company a competitive edge. For example the ability to deliver a product to a customer, complete with documentation, a few minutes before a competitor, because it was already on a delivery truck can help keep customers and win new business.

But people who travel are not only on business. These very same people are also wives, husbands, mothers, fathers, daughters, sons, sisters, brothers, or friends of friends. And they need to communicate with each other, and often need to gain access to data that relates to their personal lives as well as their business.

The idea of telecommunications equipment becoming consumer electronics items on a par with radio and television receivers, portable tape recorders and audio equipment has already begun to change the culture of both the telecommunications industry and its customers. All types of terminals from basic telephones through to facsimile transceivers that less than ten years ago were regarded as sophisticated professional equipment have taken their place in the retail stores in the main shopping centres of Europe. Computers have followed the same path into the home.

It is certain then that when telecommunications equipment and computers converge, whatever the final form of end product there will be a consumer market need to be filled. The question that remains, however, is whether the average consumer will put such products to the uses their inventors intended them for.

1.2. Culture Changes

The social fabric of society is diversifying with regard to the geographical spread of families and friends and the distance between employment and the home. This promotes the underlying demand for passenger transport, as more people travel further to visit friends and relatives, and for their work obligations.

In addition to these trends, there are a number of other structural changes in society which stimulate the demand for increased mobility. These include the growing number of out-of-town shopping malls, the rationalisation of schools, school choice, and the increase in separated families. We have also seen the population of the cities in Western Europe decline, as more people move to surburban and country areas.

All these factors contribute to yet another phenomenon of the late 20th century, the growth in the number of people who find they can carry out their work without physically travelling to the same place as their colleagues. They are teleworking.

While this mode of working is currently applicable only to a few hundred thousand people, some forecasters estimate that there could be as many as 5 million teleworkers in Europe by the turn of the century. It is these people who will mark the merging of business and non-business applications for mobility in data communications.

2. Technology and Market Overview

The radio spectrum has become a very valuable asset, and it is no surprise that it is guarded by many different interests. For it is truly the invisible infrastructure that will be as significant as the railways were to the industrial revolution. This has led to a number of standards in each area with several such as DECT overlapping from voice into data communications. In this section we'll look at each industry in turn, indicating the technology shaping the market and how the market is developing.

2.1. Analog Cellular

The analog cellular market has 6.8 million subscribers around Europe providing a 1993 revenue of 1.25 billion ECUs. The analog cellular market, whilst the biggest cellular phone market in Europe, is seeing declining shipments as digital cellular supersedes it.

2.1.1. Technology

The first truly commercial analog cellular services in the world were launched in Scandinavia around the end of 1981, based on the NMT-450 technology developed in co-operation between the Nordic operators and manufacturers. Cellular services proved an immediate and ongoing success in Scandinavia, and by the end of 1986 had been launched in most other European countries.

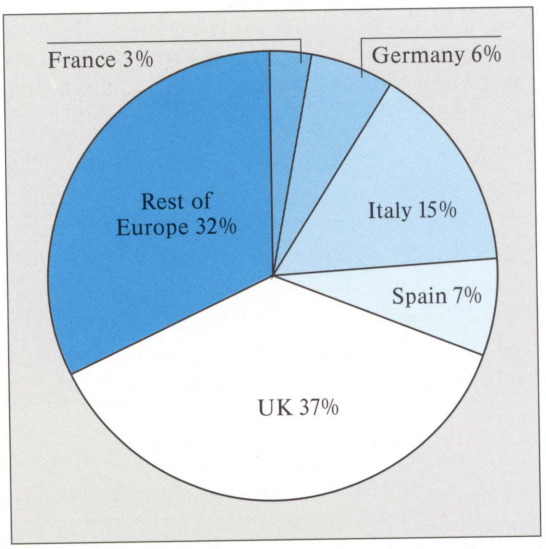


Figure 1
Analog Cellular Telephone Shipments, 1993

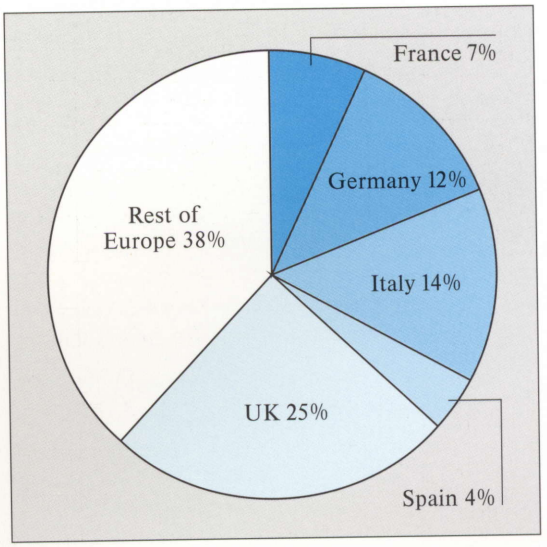


Figure 2
Analog Cellular Telephone Subscribers, 1993

Table 1
Analog Cellular Telephone Shipments, 1991-93

Year Country	1991 Shipments (1,000)	1992 Shipments (1,000)	1993 Shipments (1,000)	CAGR 91-92	CAGR 92-93
France	97.7	76.1	52.9	- 22%	- 30%
Germany	269.2	273.1	102.7	1%	- 62%
Italy	343.5	311.4	242.2	- 9%	- 22%
Spain	61.0	91.3	108.1	50%	18%
UK	266.2	395.2	573.7	48%	45%
Rest of Europe	442.9	512.0	514.3	16%	0%
Europe	**1,480.5**	**1,659.2**	**1,593.8**	**12%**	**- 4%**

Table 2
Analog Cellular Telephone Subscribers, 1991-93

Year Country	1991 Subscribers (1,000)	1992 Subscribers (1,000)	1993 Subscribers (1,000)	CAGR 91-92	CAGR 92-93
France	375.3	437.0	472.3	16%	8%
Germany	541.9	780.6	806.0	44%	3%
Italy	567.5	782.8	929.0	38%	19%
Spain	108.7	180.7	254.3	66%	41%
UK	1,233.5	1,397.2	1,708.3	13%	22%
Rest of Europe	1,851.1	2,279.1	2,675.8	23%	17%
Europe	**4,678.0**	**5,857.4**	**6,845.6**	**25%**	**17%**

Table 3
Analog Cellular Telephone Revenues, 1991-93

Year Country	1991 Revenues (Million ECUs)	1992 Revenues (Million ECUs)	1993 Revenues (Million ECUs)	CAGR 91-92	CAGR 92-93
France	184.4	128.2	79.9	- 30%	- 38%
Germany	650.1	466.2	125.0	- 28%	- 73%
Italy	398.9	276.1	173.1	- 31%	- 37%
Spain	67.6	89.6	73.5	33%	- 18%
UK	200.0	226.9	287.6	13%	27%
Rest of Europe	671.6	663.0	513.9	- 1%	- 22%
Europe	**2,172.6**	**1,850.1**	**1,253.0**	**- 15%**	**- 32%**

The success of NMT-450 in the Nordic countries was such that, by 1985, capacity around major cities was already under strain. Again, the operators co-operated with suppliers to produce a 900MHz standard (NMT-900), to support greater traffic densities and the use of hand-portable units. Initially launched across the Nordic region in December 1986, NMT-900 was subsequently adopted as a second system in the Netherlands, and for the first network in Switzerland.

Such co-operation between operators in developing and implementing common technology, however, was not a widespread feature of the European analog cellular industry in a period when implementation of telecommunications standards and frequency allocation were primarily national functions. The Nordic countries were followed by Spain, Austria, the Benelux countries and Turkey, in using modified versions of NMT-450, but other operators, for either political or pragmatic reasons (e.g. availability of frequencies), decided to adopt different standards.

In the UK and Ireland, TACS, a modified version of a US standard, was chosen for launch at the start of 1985. TACS supported the first hand-portable units in Europe. When the UK operators ran into capacity problems, they were fortunate in having a willing regulator, with frequencies being extended in areas of highest demand. Success in the UK market helped to make TACS an attractive option for Italy, Austria, and Spain when choosing their second analog systems.

In France, Germany and Italy, the PTO operators turned to local manufacturers for initial solutions - initially adopting Radiocom 2000, C-450 and RTMS respectively. In France, where availability of frequencies has generally proved problematic, a second operator was licensed and implemented yet another standard variation in NMT-F.

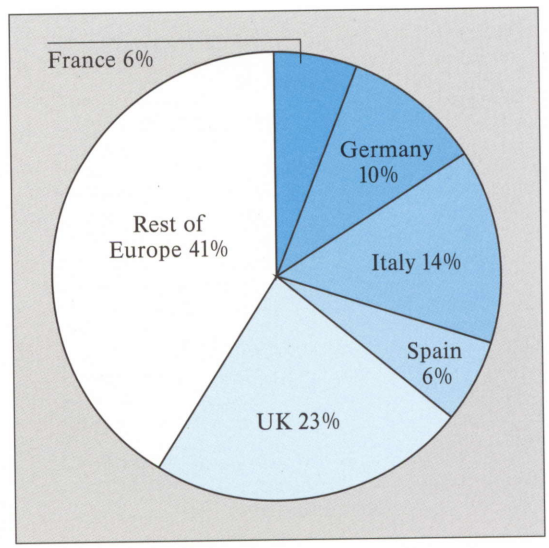


Figure 3
Analog Cellular Telephone Revenues, 1993

The European analog cellular market, then, represents not one market but several - a "patchwork quilt" of systems, with launch dates spread over the past decade, and with limited areas of roaming.

2.1.2. Data Transmission

In analog systems, the prospective user of data-over-cellular requires a cellular phone, a data interface and a suitable modem to provide remote access to his PC or terminal.

Cellular handsets: Take several forms. The early market was dominated by mobiles - products fixed in cars and using the car's battery as their power source; and by transportables - operationally similar but with their own battery and aerial built in. Such products continue to dominate in low frequency standards such as NMT-450, C-450 and Radiocomm 2000.

Table 4
Analog Cellular Standards in Operation by Country

Country	Standard
Andorra	NMT-450
Austria	NMT-450, TACS-900
Belgium	NMT-450
Cyprus	NMT-900
Denmark	NMT-450, NMT-900
Faroe Islands	NMT-450, NMT-900
Finland	NMT-450, NMT-900
France	RC-2000, NMT-F
Germany	C-450
Iceland	NMT-450
Ireland	TACS-900
Italy	RTMS, TACS-900
Luxembourg	NMT-450
Malta	TACS-900
Netherlands	NMT-450, NMT-900
Norway	NMT-450, NMT-900
Portugal	C-450
Spain	NMT-450, TACS-900
Sweden	Comvik, NMT-450, NMT-900
Switzerland	NMT-900
Turkey	NMT-450
UK	TACS-900

Within the 900 MHz standards of NMT-900 and TACS, however, hand-portable units have come to represent the dominant sector. Operating at lower power output levels in order to minimise battery size and weight, leading models today weigh around 200 g. Many are used in conjunction with in-car kits and even power-boosters.

Cellular data interface: Connects between the cellular handset and transceiver, providing a standard telephone socket termination for connection of a modem or fax machine.

Modem: May be stand-alone or integral – converts the digital output to analog for transmission on the network.

As a medium for data transmission, analog cellular combines the normal problems associated with the PSTN with the characteristics of analog radio propagation, and cell-to-cell handover. The latter is a particular problem which often results in data drop-out.

Any modem used on an analog cellular network must employ a robust error correction protocol. Some products developed specifically for cellular use combine multiple error correction techniques, and may even incorporate a layered protocol to establish and manage the data link for effective information transfer. If a specialised modem is used with the cellular phone, there must be a similar unit either at the ultimate receiving end or within the fixed part of the cellular network.

Even with specialised cellular modems, data throughput in today's analog cellular networks rarely exceeds 4,800 bps – sufficient perhaps for basic messaging, but limiting for transfer or retrieval of significant amounts of information.

The limited facility for roaming outside the home country is certainly more of a restriction for mobile data users than for those only interested in voice communications.

Whilst it is certainly possible to transmit data over existing analog cellular networks, performance and coverage limitations have meant that use of this facility has been restricted to a very small percentage of subscribers.

2.2. Digital Cellular

Digital cellular phones started selling in 1992 just breaking through the million subscriber barrier by the end of 1993, a growth of over 400% compared to 1992. We expect digital cellular (1.7 million) to sell more cellular phones in 1994 than analog (1.2 million). Digital cellular phones are much more friendly to data transmission than analog ones, with the expected wireless data terminal relying on digital cellular technology.

2.2.1. Technology

In contrast to its analog precursors the development of digital cellular in Europe has been a story of co-operation across the industry on a previously unprecedented scale. From the early 1980s, it became apparent that a standard which was adopted in all European countries, would provide significant benefits to operators, manufacturers and users alike. GSM, the pan-European digital cellular standard, overcomes many of the limitations of analog cellular, and includes many new capabilities within its specification – effective data communications and ISDN compatibility being key elements.

Having been originated within the CEPT, GSM became one of the first major projects for the European Telecommunications Standards Institute (ETSI). Input into the developing standard thus came from a wide variety of sources – although primarily from operators and manufacturers.

The European Commission has played a key role. Its frequency directive to member states was intended to guarantee that sufficient spectrum would be available upon which to operate competitive services. In attempting to open the market to competition as much as possible, the European Commission issued directives to ensure competitive provision of services, mutual recognition of terminal type-approval, and open procurement of infrastructure equipment.

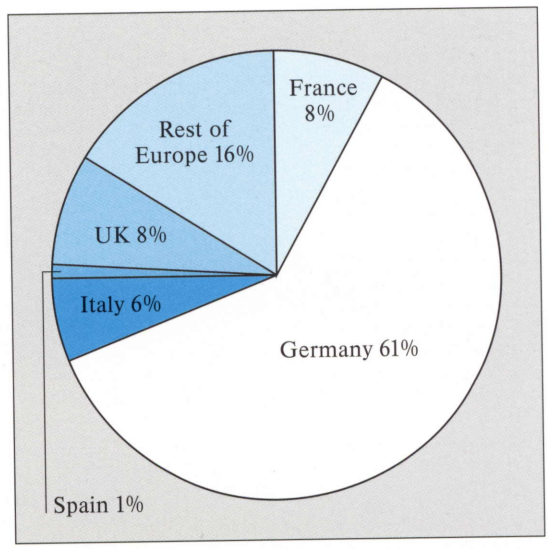


Figure 4
Digital Cellular Telephone Shipments, 1993

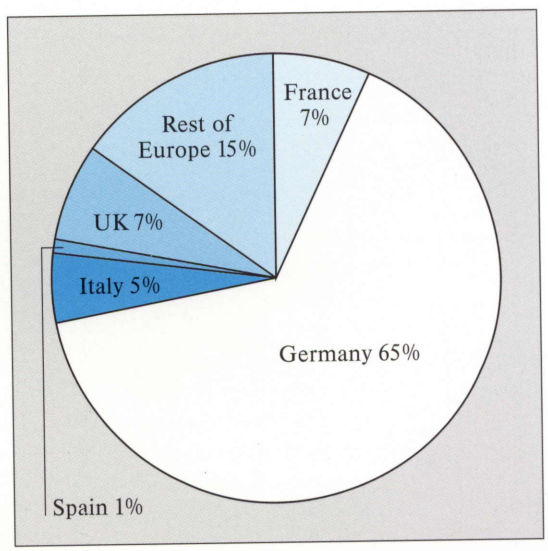


Figure 5
Digital Cellular Telephone Subscribers, 1993

Table 5
Digital Cellular Telephone Shipments, 1991-93

Year Country	1991 Shipments (1,000)	1992 Shipments (1,000)	1993 Shipments (1,000)	CAGR 91-92	CAGR 92-93
France	0.0	1.5	71.0	NA	4,744
Germany	0.0	157.6	528.5	NA	235
Italy	0.0	0.3	49.0	NA	18,757
Spain	0.0	0.0	5.5	NA	NA
UK	0.0	1.0	72.9	NA	7,193
Rest of Europe	0.0	10.4	139.6	NA	1,241
Europe	**0.0**	**170.7**	**866.5**	**NA**	**408**

Table 6
Digital Cellular Telephone Subscribers, 1991-93

Year Country	1991 Subscribers (1,000)	1992 Subscribers (1,000)	1993 Subscribers (1,000)	CAGR 91-92	CAGR 92-93
France	0.0	1.5	69.7	NA	4,659
Germany	0.0	157.6	671.3	NA	326
Italy	0.0	0.3	47.7	NA	18,263
Spain	0.0	0.0	5.5	NA	NA
UK	0.0	1.0	69.7	NA	6,873
Rest of Europe	0.0	10.4	146.6	NA	1,308
Europe	**0.0**	**170.7**	**1,010.6**	**NA**	**492**

Table 7
Digital Cellular Telephone Revenues, 1991-93

Year Country	1991 Revenues (Million ECUs)	1992 Revenues (Million ECUs)	1993 Revenues (Million ECUs)	CAGR 91-92	CAGR 92-93
France	0.0	1.8	77.9	NA	4,333
Germany	0.0	148.9	514.9	NA	246
Italy	0.0	0.2	52.9	NA	23,039
Spain	0.0	0.0	6.1	NA	NA
UK	0.0	1.3	67.9	NA	5,165
Rest of Europe	0.0	12.1	151.8	NA	1,158
Europe	**0.0**	**164.3**	**871.5**	**NA**	**431**

The European Commission also played an important supporting role in the establishment of the GSM Memorandum of Understanding group (MoU) of existing and prospective operators. Originally signed by 12 European Countries in September 1987, the MoU was seen as crucial in gaining a co-ordinated implementation of GSM to facilitate international roaming. By June 1993, membership had expanded to 56 signatories from 33 countries around the world. The MoU now comprises a number of working groups which have been set up to create policies on such practical issues as open network interface standards, inter-country roaming etc. Working closely with the GSM, the MoU provides the operators' collective input to the standards setting process, with a focus on commercial/financial considerations.

The major focus of all these co-operations and directives, has been to create a standard which makes the best use of available spectrum and hence maximises subscriber capacity; which as a common standard will provide much greater economies of scale than its various predecessors, and attract greater competition amongst suppliers; in which there is the optimal, and flexible, trade-off between equipment and service features and the prices they can demand. All these factors are interlinked. The overall aim was to create a standard which would offer the maximum market potential within Europe at this time, and which would further repay the co-operative efforts through its subsequent exportability outside Europe.

Given such complex goals, it is perhaps not surprising that the standardisation process ended up taking longer than had been envisaged. To facilitate "early" commercial implementation, the specification was split into two phases. Phase 1 concentrated on defining a limited set of "basic" functions, whilst phase 2 represents the full GSM standard.

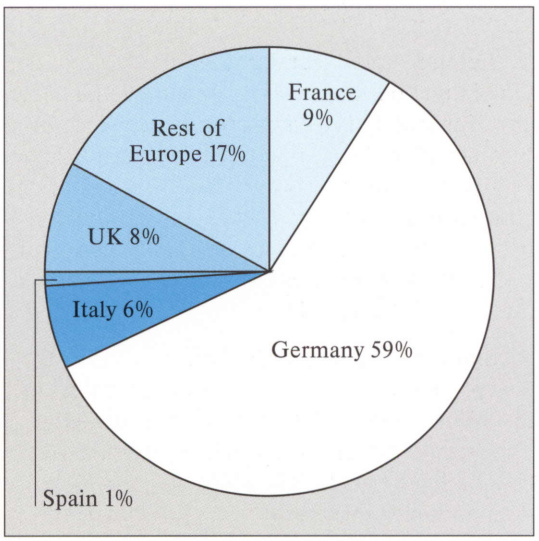


Figure 6
Digital Cellular Telephone Revenues, 1993

Nevertheless, the launch date of July 1, 1991, agreed by the European operators, was to prove impossible to meet. Commercial services finally launching from mid-1992 after delays in finalising specifications. With phase 2 specifications to become available from late 1994, developers have already started to consider additional functions which would further enhance GSM's long-term potential - the so-called phase 2+ elements.

It is important to note that whilst the GSM specification includes many novel features and functions it is largely up to the operators to decide which elements they wish to implement on their networks and when. Given perceived demand and the incomplete nature of data specifications, the initial focus has clearly been on voice services, with short messaging available on a limited number of networks by the end of 1993.

2.2.2. Data Transmission

Being a digital standard, sending data over a GSM link does not necessitate a modem at each end. The fact that the data are arranged in a fixed format and sent at a fixed rate on the air interface, however, makes the transmission of data more complicated than might be expected. There are, in fact, several data transmission options already within the GSM specification or under consideration for future adoption:

Short Message Service (SMS): In the "two-way paging" element of the GSM specification, up to 160 bytes of data can be transmitted on a point-to-point basis from mobile-to-fixed, fixed-to-mobile or mobile-to-mobile; or up to 82 bytes on a point-to-multipoint "Cell broadcast" basis. SMS is included in phase 1 of the GSM specification with further functionality added during phase 2.

Circuit Switched Data: Being a TDMA-based system, GSM reduces the potential problems caused by cell-to-cell handover. 9.6 kbps is available to the user of the total of 22.8 kbps – the balance being used for Forward Error Correction redundancy. The user may choose between transparent and non-transparent, synchronous or asynchronous use of the channel.

Bearer services defined within Phase 1 of the GSM specification include:

- Asynchronous Data 300-9600 bit/s, including 1200/75 bit/s;
- Synchronous Data 300-9600 bit/s;
- Asynchronous PAD Access 300-9600 bit/s;
- Alternate Speech and Data 300-9600 bit/s, with the "sub mode" Speech followed by Data 300-9600 bit/s.

Whilst officially included in phase 1, not all of these specifications were 100% complete. Operators wishing to implement data services would have to fill in some of the blanks themselves – although with the benefit of being able to track further development of the final standard within ETSI.

Packet Mode Working: The major development within phase 2 of the GSM specification is that of access to packet data networks. This element of the standard primarily intended for point-to-multipoint applications but will also cater for point-to-point communications in conditions where neither SMS nor circuit switched services are ideal. Synchronous Dedicated Packet Access 2400-9600 bit/s is the sole addition to the list of bearer services within phase 2 of the specification.

Packet Radio Mode: Under discussion for inclusion within the phase 2+ specifications, packet radio might facilitate introduction of new applications such as road transport informatics, fleet management systems and other such data applications.

Initially, GSM has been adopted for its voice functionality. Low prices for terminals combined with lower tariffs will drive cellular towards commodity and ultimately consumer status. Whilst the primary focus will continue to be voice, we have noted a distinct shift in operator perceptions of the potential for data communications over the last two years; private operators in particular view this as an important aspect of their future operations.

One benefit which GSM will provide is a common digital transmission standard across Europe. Different PSTN network standards, from signalling techniques and approved modems, right down to the types of phone sockets used (if any), make remote international access of the home

system by the travelling PC user almost impossible. In this sense, it is GSM's standardisation rather than its mobility which is most beneficial.

This advantage to GSM grows even greater as the number of new operators and regulators outside Europe choosing the standard continues to accelerate. GSM is well positioned to become the de facto standard for first generation digital cellular, and with it the world's most pervasive standard for remote data communications, a fact recognised by computer manufacturers as well as potential users.

2.2.3. DCS 1800

In 1989, the UK government decided to licence operators of what it termed "Personal Communications Networks" (PCNs). The basic concept was of a micro-cellular telecommunications service, targeted at the mass market, in which a telephone number was associated with a person, rather than a place. PCN operators, it was hoped, would compete both with the existing cellular operators and with PSTN service providers. The major reason they could compete, especially in the consumer market, is the increased subscriber density of DCS 1800 over other competing systems.

GSM was ultimately chosen as the technology basis for PCNs. The resulting standard, Digital Cellular Standard 1800 (DCS 1800), deviates only in minor ways from GSM and has been incorporated into phase 2 of the GSM specification. Whilst not perhaps the optimum standard to support all aspects of the PCN definition, choosing GSM provided benefits in timeliness and wide acceptance across Europe, with concurrent commercial advantages. It has come to be recognised, however, that DCS 1800 is best suited to targeting the developing market for cellular services - competing with GSM to stimulate and satisfy an ever-growing demand in both business and consumer sectors for mobile communications services. It now seems unlikely that DCS 1800 poses any immediate threat to PSTN operators.

DCS 1800 is largely seen as the next step in cellular services, and its implementation is currently a matter for local regulators alone. In the UK, three operators were licensed in 1989, their number dropping to two by the launch of the first services in September 1993. In late 1992 a DCS 1800 license was awarded in Germany to an operator which is positioning itself to compete with its two GSM rivals launching services from 1994, with an initial focus on the old East German states. In late 1993, the French telecommunications regulator announced that it would also license a new operator to offer DCS 1800 services, and would allow France Telecom and SFR to apply for DCS 1800 licences, albeit under less favourable conditions.

Whilst DCS 1800 is identical to GSM at 900 MHz in many ways, it is likely to be targeted even more strongly at consumer users, and will certainly offer more restricted coverage. In our view, supporting data communications is likely to remain a secondary focus for operators in the short term.

2.3. Telepoint Systems

Telepoint systems have only appeared in five European countries with mixed success. They offer a potentially useful combination of a wireless phone that works both inside and outside a building.

2.3.1. Technology

In the mid-80s, with sales of analog cordless telephones in the residential sector starting to grow dramatically, two European groups began working on a second-generation of cordless tele-

Table 8
Commercial Telepoint Services in Europe

Country	Operator	Status
Belgium	Belgacom	Pilot around Brussels
Finland	Telecom Finland	Pilot around Helsinki
France	France Telecom	Commercial (Paris & Strasbourg)
Netherlands	PTT Netherlands	Commercial (Nationwide)

phones. Digital technology would allow handsets to be used in an office environment, ultimately on the back of a cordless PBX, and by making the systems frequency dynamic, it would be possible to vastly increase the user-densities available.

A further new opportunity arose from these developments, in the form of Telepoint services - in which a subscriber may make calls in public areas which have been equipped with base-stations. Telepoint systems do not provide contiguous coverage; neither do they constantly track the position of the user in order to be able to connect incoming calls. With no cell handover, Telepoint does not require the complex equipment and system management capabilities associated with cellular telephony.

One group comprised a number of UK based telecommunications manufacturers, the other was the CEPT. The latter eventually creating the DECT standard for wireless voice and data. In spite of an impending European standard, the UK went ahead and in 1987 allocated the frequencies and published the technical standards. In 1989, the UK Department of Trade and Industry licensed four operators of CT2-based Telepoint services. In their haste to maximise the window of opportunity for Telepoint before PCN became available, three of the four licensees launched services in late 1989, based on proprietary versions of the CT2 standard. Largely due to a combination of immature technology, low investment and insufficient, inappropriately targeted marketing, all three services failed to attract significant numbers of users, and had suspended operations by the end of 1991.

The continued support given to CT2/CAI by the UK government, other countries, and leading developers did have a positive political result, however, as the standard was adopted by ETSI in April 1991. Some operators have gone ahead with Telepoint launches, including the fourth of the UK licensees - all, so far, utilising CT2/CAI technology. By late 1993, commercial Telepoint services in Europe were as in *Table 8*.

2.3.2. Data Transmission

Whilst CT2 is primarily targeted at voice communications applications, data applications have already started to emerge. An early example is the French solution allowing cordless access via the operator's public Telepoint service, "Bi-Bop". The radio interface can make use of conventional voice band modems at speeds up to 14.4 Kbps. The advantage of these systems is that when in the office, the same modem can be used at equivalent cost to wired rates, with the possibility of using outside the office within 100 metres of a base station.

Before addressing the impact of Telepoint on mobile data communications, however, one must seriously question how such services will continue to fare in Europe. Whilst Telepoint can claim considerable success in the far East, the concept has yet to gain any real success in Europe - particularly in comparison with the ongoing growth of cellular. The concept suffered another blow in November 1993, when the last of the UK operators announced plans to close down its network at the end of the year.

Defenders of the concept point to the lack of complementary office systems equipment until recently. It would certainly benefit the operators to be able sell Telepoint as a value added facility on the back of a large installed base of CT2 equipment in the business sector, rather than purely on its own merits. One major point of debate has been whether Telepoint's predominantly one-way nature will ever be accepted by the public. At the end of 1993, new facilities are to be launched which will test whether a larger group of users will be satisfied with basic two-way mobility at a budget price. France Telecom, will offer the facility for users to "log-on" to a specific base station, to which incoming calls will then be routed.

1994 should decide whether Telepoint services continue to survive at all in Europe. Only if the operators can persuade a larger public that Telepoint provides the right price/performance equation for mobile voice communications, will the prospect of mobile data over this service start to gain real significance.

2.4. International Paging

Paging is the longest serving mobile data technology with an estimated 2.75 million pagers sold in Europe in 1993. The growth of sales of pagers having slowed to around 16%. Paging remains the cheapest and most widely available technology for sending brief bursts of data.

2.4.1. Technology

The infrastructure required to support paging services is now well-established and reliable. In particular there are a number of agreements in place which allow pager users to roam over several countries - the Euromessage Consortium for example, which covers most of Western Europe. To extend the reach of their paging services, some operators have adopted satellite communications techniques.

The paging service operators are evolving new strategies in an effort to maintain their markets. These centre on marketing paging receivers to domestic consumers and to customers of broadcast data services. These services are like the teletext services broadcast along with television signals, rather than true data communications systems. The main difference between teletext and paging is that there is an ability to code signals so that they may be addressed to one individual or to specific groups of individuals. This allows the provision of value added services in the sense that data pager users can subscribe to receive specific types of information.

This subscription requires the introduction of new types of "smart" paging receivers that have text or graphical displays, relatively large memories and a modicum of processing power. Information on offer by various network operators ranges from a continuous feed of financial information from analysts such as currency, stock and commodity exchanges, through to traffic and congestion reports and theatre ticket availability. This can be updated as frequently as once a minute. Many systems allow users to set their own alarm limits so that when a business user hears his pager beep, he knows that it may be time to sell or buy a particular stock.

This type of information can be further extended when the pager is combined with a handheld computer. The computer, however, will not always be part of the machine and so these "message cards" can be carried in a handbag and continue to receive and store messages. On receiving a message, it notifies the user with a beep or a flashing light. The user can then insert the pager card into the host machine's PCMCIA slot to download the message for viewing and information processing. The addition of this technology will allow further increases in revenues for the paging service providers.

The long range hope for the European pager business is the planned launch of the ERMES, pan-European, digital paging network in 1994. It uses common frequencies throughout Europe and it can handle much higher data transmission rates.

2.5. Packet Radio

The packet radio market today consists of a small number of vertical market segments which makes it a difficult market to quantify. The market has potential to become horizontal and therefore grow dramatically when portable, pen-based terminals become more prevalent in the next three to four years.

2.5.1. Technology

In the early-1980s it was realised that 30 seconds of data could contain as much information as a three minute voice conversation. As a result in situations where the available spectrum was strictly limited, the use of data radio rather than radio telephony could significantly increase the capacity of a network.

Early applications included radio despatcher services – for example to direct taxis or delivery vehicles – or in closed sites such as docks and ports handling containers and ship's cargoes. The efficiency of such services having been proven in closed private networks, several public services have become available which use packet radio technology. Typically these occupy frequencies vacated by obsolete radio telephone services.

Packet radio uses data formatted into discrete pieces or "packets" each of which has its destination and sequence position incorporated in a packet header. This means that each packet can be routed to its destination independently of all others in the same data stream. This packet switching or "connectionless" approach provides a higher level of network robustness when compared to comparable circuit switched systems. This type of packet switching has been widely implemented in both public and fixed data networks around the world, usually based on CCITT Recommendation X.25.

Although there are as yet no recognised international standard for packet radio, the designers of those networks that are currently in use have generally adhered as closely as they were able to the X.25 recommendations. As a result they all claim a high degree of compatibility with existing fixed data networks. These networks are available in several countries in Europe with the major networks being in the UK, Scandinavia and Germany.

In spite of the compatibility with X.25, there are significant if detailed differences between the technologies in use. This generally results in one manufacturer's radio terminal not being able to communicate with a network built by another manufacturer. There are also variations on the theme for the network infrastructure depending on the regulatory environment and the architect of the infrastructure.

For example, in some countries where there is concern to protect existing fixed data services, live interaction between remote terminals via the fixed infrastructure is not permitted. In these instances networks must provide a "store and forward" capability that stores a message that cannot be delivered to a mobile unit, and then forwards it automatically when the terminal becomes available once more to receive messages.

2.6. Other Communications Solutions

There are several other possibilities for sending data dependent on cost and coverage. These are relatively minor in the overall market but are important in their own niches.

2.6.1. Technology

PAMR - Public Access Mobile Radio: Many corporations need to run mobile radio networks to maintain contact with their delivery or other vehicle fleets. Traditionally, such networks would be allocated a dedicated group of radio frequency channels for their exclusive use. Unfortunately, the massive increase in demand for Private Mobile Radio licences, has caused this approach to be inefficient and eventually unworkable. As a result, the concept of channel sharing using a trunking technique was evolved.

In a trunked system, a user is given exclusive use of a radio channel only for the duration of a conversation. Thus several organisations can share one channel without interfering with each other. Hence users have the all the benefits of running their own private mobile radio networks, such as low cost per conversation and closed user group facilities, but without the costs associated with building and maintaining their own transmitter sites. They may also gain the advantage of obtaining coverage over a much wider area than a self provided private network. In general it is not permitted for such networks to make direct connections to the public switched telephone network although this is technically possible.

The trunked radio operators are finding a growing demand for data services, in spite of the original aim to attract voice-only traffic. These are typically latitude and longitude co-ordinates from a global positioning system of a truck load or temperature readings from a refrigerated truck carrying perishable goods. In the future, network operators would like to see this being used for document transfer to and from the truck.

Trunked radio systems are being implemented throughout Europe. In the main these use equipment that is based on British specifications MPT-1327 and MPT-1343 which set standards for mobile radio transceivers and the infrastructure respectively. The interests of these users are administered by an international committee that includes representatives from a number of countries, including Germany, Austria, Japan, Finland, the Netherlands and the UK.

Satellite Communications. Data communications services based on use of the Inmarsat A, Inmarsat B and Inmarsat C systems are being offered for use in Europe by members of the Inmarsat consortium. In principle these services are available worldwide.

Inmarsat C is the service offered for trucks. A score of companies around the world offer complete fleet management systems. The main applications for these are vehicle tracking, telemetry and the passing of telex messages.

TETRA - Trans-European Trunked Radio Access: Work has begun on the definition of a new pan-European standard for trunked public access mobile radio systems. This will use digital tech-

niques based on time division multiple access (TDMA). The TETRA standard will in fact comprise two sub-standards: the Voice and Data standard; and the Packet Data Optimised (PDO) standard.

In addition to providing compatibility with existing packet radio and fixed X.25 data networks, the TETRA PDO standard will support a full set of messaging facilities that allow direct interconnection with other types of Local Area Network using TCP/IP protocols.

DSRR – Digital Short Range Radio: a pan-European standard, finalised by the European Telecommunications Standards Institute (ETSI) in mid 1992. Operating in the frequency bands 880 to 890 MHz and 933 to 936 MHz, DSSR is intended to be used as an unlicensed service for on site communications, mobile to mobile. Range is set around 2 kilometres. No equipment had become available at the time of writing.

2.7. Wireless LANs

The wireless LAN market is a market awaiting a standard with only 8,700 units sold, all into niche markets, in 1993. Once the standards evolve and the costs decrease, the market will start to blossom.

2.7.1. Technology

Wireless local area networks (LAN) use infra-red or radio based technology to remove the cables associated with standard, wired LANs. The primary differences between the technologies used are in price, performance, configuration flexibility, and limitations in distance. It is truly a mixed bag – in that one technology can be superior in one area but lacking in another and vice-versa.

The question of standards is a vexed one in wireless LANs because many companies believe the market won't take off until a single standard arises. The use of the radio spectrum means that this is a political as well as technical problem, which is why several companies decided to use infra-red where no radio frequency approval was necessary. This also meant that no standards evolved in the infra-red arena leading to proprietary solutions and dissatisfied customers.

The result of this is particularly crucial to the handheld computer market where infra-red forms the basis for most wireless communications. A large number of large US companies were getting worried about these incompatibilities and lack of standards, so they formed the Infra Red Data Association (IRDA) in October 1993. The association has about 75 participants including the major European, American and Japanese manufacturers. It intends to set standards first for the point to point communications between PDAs and desktop computers.

On the other hand, the radio based wireless LANs must use approved parts of the radio spectrum, so forcing some standardisation. The radio based market can be divided into three areas:

- narrowband;
- spread spectrum;
- Digital European Cordless Telecommunications (DECT).

2.7.2. Narrowband

Narrowband works in a similar way to the radio using an allotted band of spectrum split into a number of channels. This relies on accurate control and maintenance of the frequency within each channel to prevent interference from one channel to another. The channels use many different methods for communicating between a transmitter and receiver. It is possible, for example, to have multiple links on one channel by using such techniques as time-division multiple

access (TDMA), providing many logical connections on one channel. By dividing up the channels in the time domain and allocating slots in time to different receiver/transmitter pairs, many users can appear to be using a single frequency.

The benefits of narrowband are that it allows for more bandwidth than spread spectrum and, because it is on a designated bandwidth, it does not have potential interference problems. The biggest disadvantage of narrowband is that it requires an FCC license in the US and licenses from the different regulatory bodies in Europe and Japan. This has lead to only a small number of manufacturers employing the technique for wireless LANs.

2.7.3. Spread Spectrum

Spread spectrum was developed at the end of World War Two for covert operation where it was essential to prevent eavesdropping and decryption. It provides a very secure method of communication that is resistant to interference and can coexist with others of the same band of the spectrum. The first spread spectrum wireless LAN products used 902 to 928 MHz but the band is used by cellular telephones in Europe. This meant that the products had to be modified to work in Europe so few companies bothered.

Today, the next generation of spread spectrum wireless LANs have moved to the 2.4 to 2.5 GHz Industrial, Scientific, and Medical (ISM) band because of less congestion and the lack of US license. This band has now become the standard band for spread spectrum LANs in Australia, New Zealand and Japan. This is quite strange since the band is still being used by a number of radio sources including microwave ovens.

Europe had a tricky problem since it had already approved the DECT standard, but did not want to lose the cost benefits of a global standard. ETSI has therefore issued a draft regulation covering wireless LANs in the 2.4 to 2.5 GHz which is undergoing public discussion and should be approved by March 1994. A number of European countries, including the UK and Germany, have fully approved products based on local rules while the rest of Europe with the exception of France have issued temporary approval pending ETSI standards. In France, although ETSI has allocated this frequency range for wireless LANs, suppliers of such networks must wait for the Prime Minister's Telecommunications Advisory committee to approve this allocation. This will take some time because the range is currently used by the French armed forces. The result is that the product is on sale in France only for "experimentation" purposes.

The 2.4 GHz wireless LAN product is seen by the US and Japanese manufacturers as the current de-facto standard. They make up the majority of the market so it is likely that when ETSI approve 2.4 GHz, we will see the market flooded with these products. In spite of this, wireless LANs will remain a niche in the overall networking market.

2.7.4. DECT

DECT was ratified in July 1992 as the pan-European standard for wireless voice and data communications. It has special status in Europe as the European Commission has made it a mandatory standard for adoption by all member states. It also means that equipment tested for conformity to the standard by one accredited laboratory must be considered approved for use in all member states. This testing, plus the allocation of a pan-European frequency band at 1.88 to 1.9 GHz, will enable vendors to develop a single product that can work in all European countries.

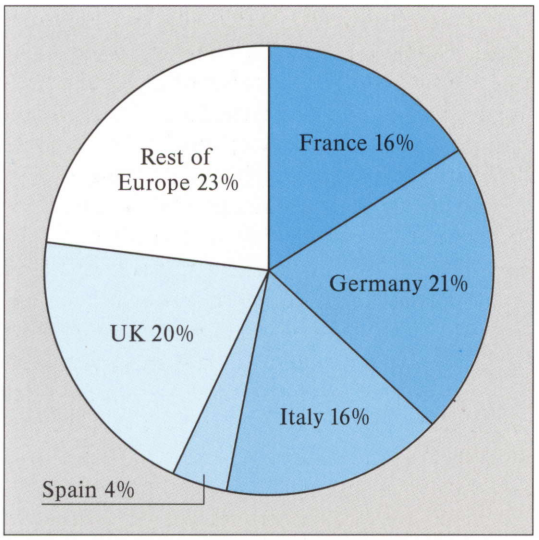


Figure 7
Notebook Shipments, 1993
(see Table 9)

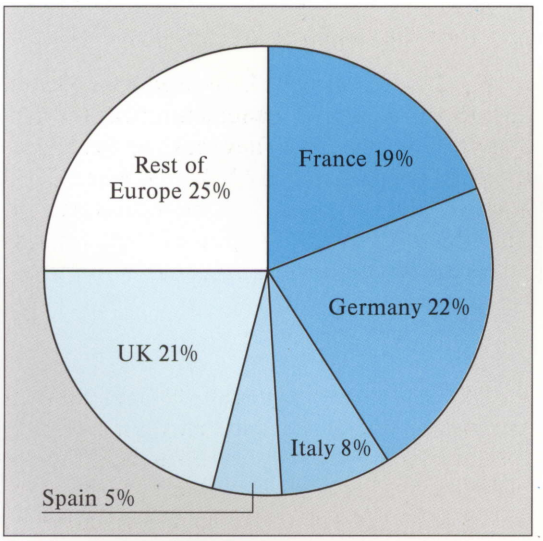


Figure 8
Notebook Revenues, 1993
(see Table 10)

The market currently has only one entrant though several European manufacturers have promised products in 1994. The non-European manufacturers, which dominate the wired LAN market, have shown little interest in making DECT wireless LANs. This is because it offers little advantage over the 2.4GHz products and it is purely a European standard.

2.8. Personal Computing

In the personal computing market, notebook sales reached almost 1.6 million units in 1993, with revenues of 4.5 billion ECUs. The PDA market, however, is a market for the future with a mere nine thousand sales in 1993.

2.8.1. Technology

In the beginning there was the transportable computer that was the size of a sewing machine with a CRT display. Today, the machines have shrunk down to the size of an A4 pad of paper mainly because of the use of LCD displays and small footprint hard disks. These notebooks have become the classic portable PC but it is inevitable that over the next few years that these machines will get lighter and thinner to bring a new class of device to market: the subnotebook. These will achieve their size by including only those pieces necessary for working on the move, others such as a connection to a LAN being placed in a docking station that sits on the desktop. In whatever form, people use these machines as replacements or supplements to desktop PCs, largely running the same operating systems and applications as used on their desktops.

The link with the desktop means that notebook computers are increasingly running a graphical user interface or some other graphical environment. This makes greater demands on the hardware than the character-based environment and forces users to upgrade their hardware.

Year Country	1991 Shipments (1,000)	1992 Shipments (1,000)	1993 Shipments (1,000)	CAGR 91-92	CAGR 92-93
France	107.6	212.0	285.1	97	34
Germany	114.6	236.5	362.3	106	53
Italy	45.6	123.9	285.1	172	130
Spain	33.8	53.7	69.2	59	29
UK	115.5	219.8	338.8	90	54
Rest of Europe	160.0	301.1	387.5	88	29
Europe	**607.0**	**1,147.0**	**1,597.4**	**89**	**39**

Table 9
Notebook Shipments, 1991-93

The graphical nature of the environment places great strain on the storage and graphics subsystems of the notebook, perhaps the weakest part of the technology.

The display has seen the greatest changes over recent years with the difficult-to-read LCD a feature of the past. Today, the notebook manufacturers have new forms of LCD displays, including double scan colour and active matrix at their fingertips. There are basically two sorts of LCD display matrix: active and passive, the active matrix being the hardest to make because it requires a working transistor for every pixel of the display, three pixels making a single point in a colour display. The yields of active matrix displays are under 50%, which is significantly lower than passive LCD displays and the cost is therefore significantly higher than the passive displays. This has led to only the most expensive products receiving active matrix, colour displays. The introduction of the passive, double scan colour has finally brought acceptable colour at a reasonable price.

The other part of the notebook under strain from the graphical interfaces is the storage system. This has grown from a 20 Mbyte hard disk to the current standard of 120 Mbytes to cope with the increasing size of the applications and operating systems. The footprint of the hard disk has shrunk as the capacity has increased with the result that some hard disks can be on plug-in cards. A good example of this shrinkage in size is the 1.3 inch, 40 Mbyte hard disk launched this year that is about the about the same size as a credit card.

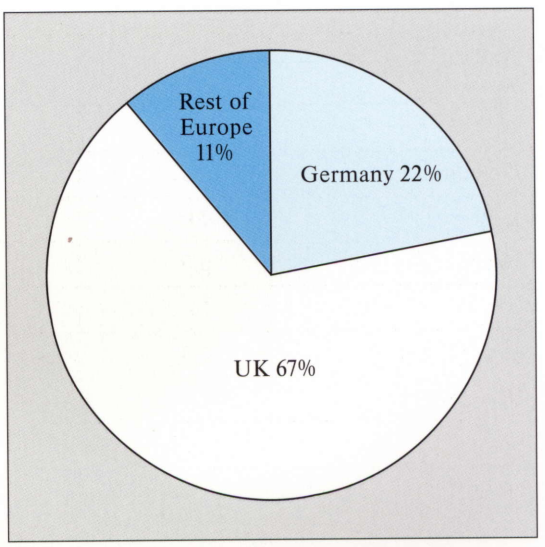


Figure 9
PDA Shipments, 1993
(see Table 11)

Table 10
Notebook Revenue, 1991-93

Year Country	1991 Revenues (Million ECUs)	1992 Revenues (Million ECUs)	1993 Revenues (Million ECUs)	CAGR 91-92	CAGR 92-93
France	402.9	791.3	865.1	96	9
Germany	501.6	861.7	1,018.7	72	18
Italy	145.3	351.3	387.4	142	10
Spain	121.3	184.7	208.7	52	13
UK	414.5	771.6	959.4	86	24
Rest of Europe	586.4	983.5	1,124.4	68	14
Europe	**2,171.9**	**3,944.0**	**4,563.6**	**82**	**16**

Table 11
PDA Shipments, 1991-93

Year Country	1991 Shipments (1,000)	1992 Shipments (1,000)	1993 Shipments (1,000)	CAGR 91-92	CAGR 92-93
France	0.0	0.0	0.0	NA	NA
Germany	0.0	0.0	2.0	NA	NA
Italy	0.0	0.0	0.0	NA	NA
Spain	0.0	0.0	0.0	NA	NA
UK	0.0	0.0	6.0	NA	NA
Rest of Europe	0.0	0.0	1.0	NA	NA
Europe	**0.0**	**0.0**	**9.0**	**NA**	**NA**

Table 12
PDA Revenue, 1991-93

Year Country	1991 Revenues (Million ECUs)	1992 Revenues (Million ECUs)	1993 Revenues (Million ECUs)	CAGR 91-92	CAGR 92-93
France	0.0	0.0	0.0	NA	NA
Germany	0.0	0.0	1.6	NA	NA
Italy	0.0	0.0	0.0	NA	NA
Spain	0.0	0.0	0.0	NA	NA
UK	0.0	0.0	4.9	NA	NA
Rest of Europe	0.0	0.0	0.8	NA	NA
Europe	**0.0**	**0.0**	**7.3**	**NA**	**NA**

These hard disks and other peripherals are increasingly being made to the PCMCIA (Personal Computer Memory Card Industry Association) standard. This is a common interface standard agreed by a large number of both computer and non-computer companies to allow compatibility between peripherals. PCMCIA will become the equivalent of the ISA bus in the mobile computing industry, with the inevitable spread to the desktop environment. (See figure 2-10)

PCMCIA started life as a standard memory card for handheld computers and that is where it will play an increasingly important role in the future. A computer that sits in your suit pocket must have equally small peripherals, which also need to be more robust, which is why hard disks won't be found in these products. Instead, solid state storage provided by battery backed static RAM, flash memory or ROM must be used. These are more expensive per byte than a hard disk and each has its own disadvantages: static RAM requiring battery backup which can fail, flash memory having a limited write cycle and only being block erasable, while ROM cannot be written to. This limits the capabilities of a handheld device and makes it impossible to easily emulate a desktop machine.

Notebooks and subnotebooks represent the vast majority of the portable computing market in both volume and revenue terms. The split by country in the notebook market shows that the largest market is in Germany but with the United Kingdom and France being close behind. The market for notebooks in the United Kingdom being much more advanced than the others because of the quicker take-up of new technology. The markets where personal computers have shown slower growth are slower to take to notebook computers, in particular Spain, Portugal and Greece. In these markets, the extra cost of

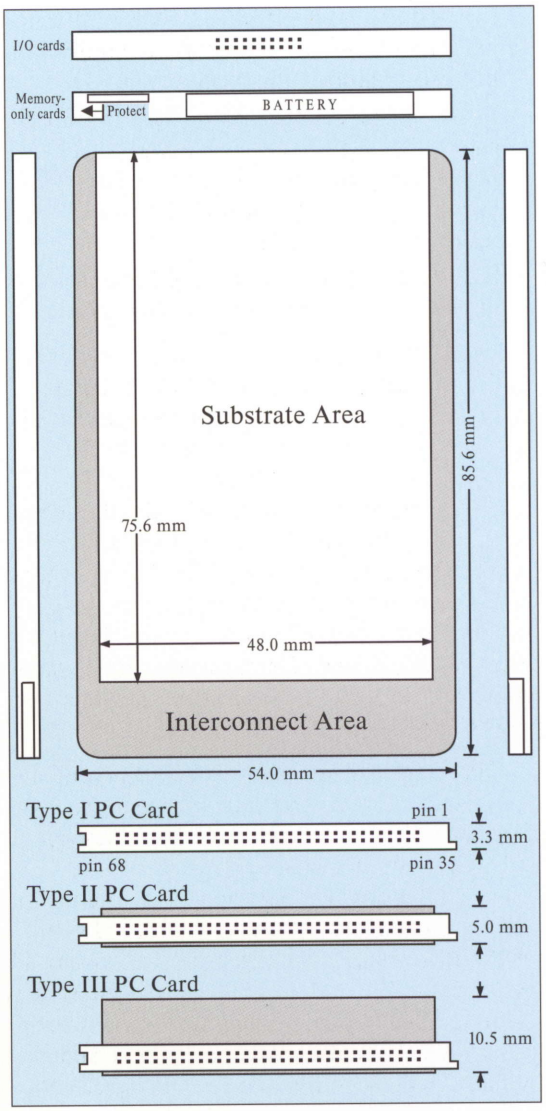


Figure 10
The Three Types of PCMCIA Card

a notebook over a desktop computer is a significant factor and the penetration of computers has yet to reach a level approaching saturation.

The handheld computers thus come in a variety of forms which we classify as:

- Organisers: keyboard-based replacements for filofaxes;

- Pen organisers: pen-based filofax replacements with no communications ability and primitive handwriting recognition;
- Personal Digital Assistants (PDA) and Personal Communications Assistants (PCA): pen-based products that combine communications with sophisticated organiser type software;
- Handheld PCs: keyboard-based personal computers shrunk down to fit in a suit-pocket.

The United Kingdom takes the lion's share of the European organiser market with Germany a significant way behind. This is because the Organiser market originated in 1984 with the first machine coming from a UK company. Its one line display is primitive by today's standards but the company has continued to grow to become one of the leading players. Their competitors have tried other countries, with Germany having the next best success. However, countries other than the UK, France, Germany and the Netherlands, remain unfulfilled in terms of organiser penetration.

Organiser sales are now faced with competition from pen organizers and PDAs from several US and European companies. In 1993, these have had patchy sales dependent on when the language translations become available. The handwriting recognition in these devices depends on the dictionary and various idiosyncrasies of the language. This takes time to work out, so for example, the most popular PDA won't make it into all countries of Europe in 1993. The success by country will therefore depend on launch dates rather than quality of the product.

When comparing the size of the markets for notebook computers against organisers, then we find that notebook machines sell three times the volume and produce thirty times the revenue. The notebook machines, acting as mobile replacements for desktops, have clearly made a significant market. Organisers have yet to break into the mass market.

3. Competition

Competition is playing and will continue to play a vital role in shaping the merging of computing and communications. In this section we look at how the market dynamics has developed and will develop.

Table 13
Potential Future Market Development of Europe versus the Rest of the World

Technology	Europe	Japan	USA
Analog Cellular	▼	■	■
Digital Cellular	▲	■	▼
Telepoint	■	■	▼
International Paging	▼	▲	▲
Packet Radio	■	▼	▲
Wireless LANs	■	▼	▲
Personal Computing	■	■	■

Key: ▲ above average position
■ average position
▼ below average position

3.1. Cellular Telephony

3.1.1. Infrastructure

As indicated previously, the analog cellular infrastructure market was dominated by specialist radio communications manufacturers. In its early days cellular communications was generally considered a limited niche opportunity, fragmented and too small to justify the investment of major telecoms vendors without existing expertise – except where a major customer was guaranteed, as in France, Germany and Italy.

Tremendous growth in analog over several years and agreement on a common, open standard across Europe in GSM has had a significant

impact on the culture of the various elements of the cellular industry. The prospect of a much larger market for infrastructure has made this a strategic area for leading telecommunications manufacturers from both within and outside Europe. Early alliances helped to spread the high cost of research and development but have generally served their useful purpose. Operators' ability to pick several suppliers for phased contracts will continue to boost the competitive pressures in this market, although some suppliers with greater expertise on the radio side have been disappointed that the MoU has not put more pressure on to create truly open interfaces. Suppliers with complete system capability currently hold the competitive advantage.

3.1.2. Terminals

Analog cellular also represented a fragmented market for terminal equipment. The early market for terminal equipment tended to be dominated by radio specialists and small (mostly Scandinavian) start-ups. Certain sectors, such as NMT-450 and the indigenous standards in France and Germany, have remained mostly the domain of local suppliers. The major markets of NMT-900 and TACS have evolved into fiercely competitive environments, however, and there has been a good deal of supplier shake out. The Japanese presence is not as strong in the United States - where a single standard has led to very large volumes - and tends to be concentrated on the TACS standard.

Again, GSM potentially represents a much larger market than any single analog standard, and has become a target for both major European telecoms vendors and Far-Eastern IT and consumer electronics vendors. This market has already become very competitive and expected to undergo further shake-out during the next few years.

3.2. Telepoint Systems

With all commercial Telepoint services launched so far based on the CT2 technology, competition has largely been limited to a handful of companies.

Whilst all of the early suppliers were UK based, there have been a number of new entrants into the market since 1992, including a major US-based cellular terminal supplier and several Japanese consumer electronics companies.

3.3. International Paging

Paging was one of the first wide area radio communications technologies to be made available in Europe during the early 1970s. Until recently, services were provided exclusively by PTTs or other national monopoly operators in Europe. More recently paging has been opened to competition from independent operators in several countries.

This competition has brought about vigorous efforts to stimulate a market that has come under pressure from the introduction of relatively low cost two way mobile communications services. This has resulted in an increasing emphasis on value added services, arrangements that allow users to be contacted as they travel across national boundaries, and by the introduction of low cost receivers. The latter has resulted in many independent and ex-PTT operators adopting consumer marketing techniques intended to appeal to ordinary consumers.

The decreasing size and availability of pager units destined for handheld computers has made the pager companies alliance with companies in the mobile computing field. The latter looking for continent wide coverage want to form alliances with pager companies that can offer a combination of value added services and pan-continental coverage through the use of satellite based repeater backbone networks.

3.4. Packet Radio

Packet radio services are believed by many to be the major technological contender for the backbone network infrastructure required to support handheld and pocket sized personal data communications units. The advantages cited include the close integration with existing fixed data communications networks that is possible with such systems. With their protocols firmly derived from X.25 standards, they will also integrate well with the short message service planned for introduction along with GSM and DCS-1800 based digital cellular networks.

As a result, there will be competition as well as collaboration between packet radio service providers and digital cellular phone network operators. While it is possible, it is not practical to provide interactive voice communications over a packet radio network, however, so in that respect the competition with networks that are predominantly voice based will be softened. Indeed, a number of the companies involved in packet radio, both as network operators and as hardware and equipment suppliers are also active in the cellular telephone and radio pager market sectors. As a result some see packet radio as a two way paging system.

At the end of 1993, the activities of packet radio network operators are constrained within national boundaries by the lack of common frequencies throughout Europe. However, many of the companies involved, independents and PTTs, do operate packet networks in several countries. This has kept competition at bay to a large extent. It is thought that this will only change when ETSI complete the definition of a common pan-European standard which encompasses packet data (TETRA).

3.5. Other Communications Solutions

PAMR - Public Access Mobile Radio - in the UK, France and Germany, there are competing services provided by regional and national independent operators. In addition in France and Germany, the national telecommunications operators also currently provide services.

In late 1993, although most nations have adopted a common technical standard covering the method of operation and management of trunked radio systems, there is no common frequency allocation. As a consequence there is at present little or no competition across national boundaries. However by definition these services are ideally suited for use by long distance transport fleet operators. We therefore expect that the introduction of the forthcoming TETRA pan-European specification should bring transnational competition between these operators. In turn this will stimulate the formation of transnational alliances, both formal and informal, between trunked radio service providers.

3.6. Wireless LANs

The wireless LAN community comes from many different backgrounds, unsurprisingly, given the diverse technologies employed. The newness of the market, the lack of standards and the focused nature of the product has led to a number of small companies investing heavily in the market.

The obvious companies to participate in the wireless LAN market are the computer networking companies. These exist but are not as numerous as expected given the minuscule size of the market compared to the wired networking market. The use of radio and spread spectrum has led to a number of spin-offs from the military radio based industry. Israel, for example, has a number of important companies in this area.

DECT has brought a number of new companies into the wireless LAN arena from the PBX side of the telecommunications community. We are likely to see DECT being sold for use both for voice and data, so these companies, with the technology developed, can offer DECT wireless LANs for a small incremental R&D cost.

The community missing from wireless LANs are the computer manufacturers who have yet to see it as a large enough market. They would like to see standards before committing wholeheartedly to it, in spite of frequent user requests. It is probable that these companies, who are watching the developments, will become major players for some wireless LAN products.

3.7. Personal Computing

The hardware side of personal computing can be split into two camps: the notebook and the organiser manufacturers. The notebook companies are the average personal computer manufacturer, typically a computer company that already makes desktop computers. These companies are finding themselves driven increasingly towards the consumer end of the market as computer prices come down and margins shrink.

These computer companies and those in consumer electronics are finding themselves coming closer together as the machine moves towards a PDA or organiser, the majority of the manufacturers in the organiser market being consumer electronics companies. These have mostly developed out of the calculator divisions of these companies as the processing power and cost have allowed more sophisticated devices.

It is clear that as communications is a cornerstone in the success of the PDA, the telecommunications manufacturers will play an increasing role. This has already started to happen in the US with the phone companies collaborating with the computing companies on several cross-over devices.

The cross-over device also demands close integration with software since most of these products will have both operating system and applications in-built. Users will not see an "operating system" but treat the applications as the operating system. This means that applications providers and hence software vendors become more critical to the engineering of a PDA. This is why both the consumer electronics and telecommunications companies are either alliancing, investing in or merging with key software companies.

4. Markets of the Future

The movement towards a more mobile society has created several new markets which will start to emerge in the near future or have already started to emerge. We shall look at the future of three of these markets, the likely barriers and the effect on the wired community.

4.1. The Merging and Emerging of the Markets

The two strands of mobile computing and mobile communications are getting ever closer. This can be seen in three ways: the increasing ability of the computer to send and receive data, the fast emergence of more mobile forms of voice and data communications and the computer masquerading as a communications device. This is creating new markets and forcing the merger of other formerly dissimilar markets.

4.1.1. Computing and Communications

The vast majority of the notebook computers being used today have little communication ability when away from the office, possessing neither a modem nor any wireless form of communications. Yet, the whole idea of a notebook computer is to have a portable personal computer, to use on the move. If you cannot communicate with the office then why bother to take the computer at all?

The reason for taking the computer is that for most businesses, the notebook doesn't need to be in data contact with a central point. This viewpoint is changing as electronic mail and groupware becomes a more accepted part of the office. These electronically enabled offices often function with little paper, so without a constantly updated electronic library the worker is lost. This

Figure 11
The Evolution of Communications and Computing Technology

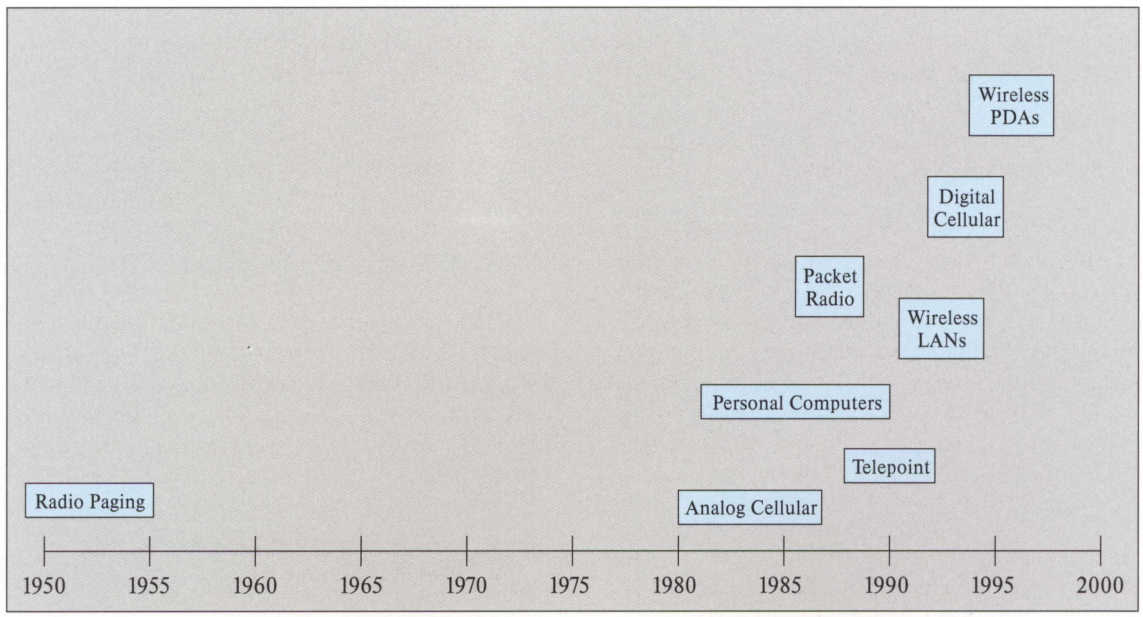


Table 14
Total Notebook and PDA Market, 1991-1997

Year	1991	1992	1993	1994	1995	1996	1997	CAGR 94-95	CAGR 96-97
Notebook & Subnotebook									
Shipments (1,000)	607.0	1,145.0	1,742.4	2,380.4	3,251.7	4,098.3	5,110.5	37	25
Revenues (Million ECUs)	2,171.9	3,971.6	4,809.5	5,666.1	6,484.3	6,950.3	7,679.0	14	10
PDA									
Shipments (1,000)	0.0	0.0	9.0	30.0	65.0	125.0	195.0	117	56
Revenues (Million ECUs)	0.0	0.0	7.3	20.3	35.1	64.1	79.0	73	23

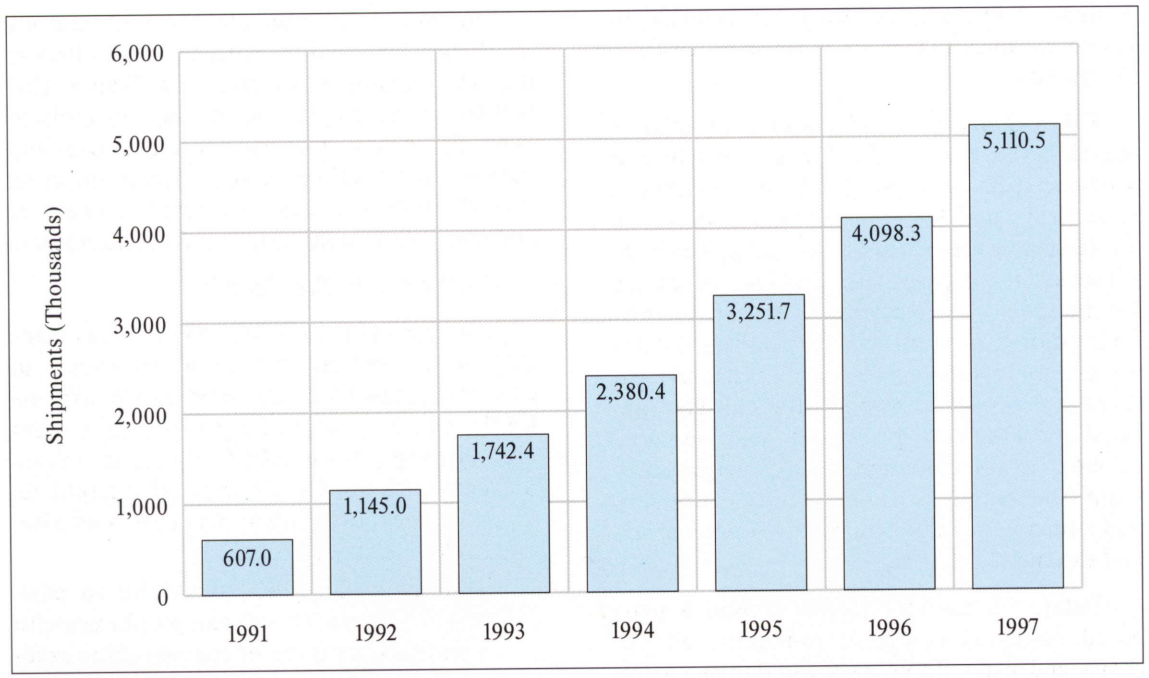


Figure 12
Notebook Market Forecast Shipments, 1991-97

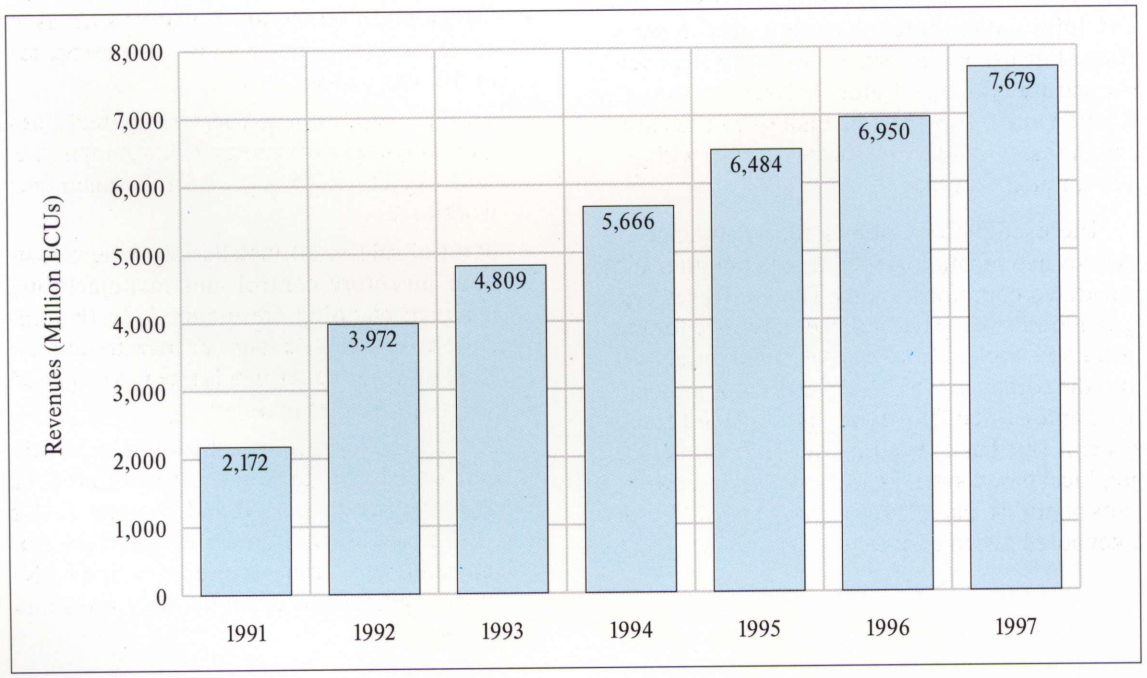


Figure 13
European Notebook Forecast Market Revenues

is what is stimulating computer vendors to see communications as an integral part of the IT structure.

This has started slowly, with a handful of technical innovators trying it before it achieved widespread acceptance. This typically happens in vertical markets, where small schemes in a limited sector can be tried. One example is from a specialist company that provides estimates for the total cost of repairing vehicles, thereby saving money for an insurance company. A damage assessor examines the vehicle and marks the damaged areas on a chart. In the old days, the numbers of the particular parts were then taken off the chart and phoned into a central data entry point. They would then enter it into a mainframe and return the resulting estimate – an error prone and expensive process.

Today, the assessor carries around a pen-based notebook computer containing all the charts and parts. They mark the damage areas with a pen on a screen representation of the car. The information entered is then sent down a phone line using a modem or over a wireless network to a central mainframe. This returns the calculation and other required data within seconds and the assessor has an error free answer without human intervention.

The example also shows the emergence of two key new technologies: the pen computer and integrated communications. The pen-based system allows a more natural user interface for the untrained worker. It allows people to enter data into the computer while holding the computer in one hand, a feat difficult with the keyboard based system. This has opened up the market to more graphical based systems such as marking the repairs on the car plan. These are impossibilities for a keyboard based system.

The ability to integrate the software for communications within vertical or horizontal markets remains a key area of difficulty. This will be solved by the introduction of tools to allow the universal transferral of data over any data communications medium. Once in place, this will allow make the merging of computers and communications to become commonplace.

4.1.2. Cutting the Cord

The growing population of portables means that the expectations that people can come and go as they please will increase the call for wireless LANs. A mobile user will expect within the next few years to go into an off-site office and tap into the network as easily as picking up the telephone. This is not happening today, however, with wireless LANs being used for

- temporary replacement or addition to existing wired networks (for example, for use with a seasonal work force, or upgrade of the existing wired LAN);
- formation of temporary networks such as at an exhibition, a trade show, an emergency or disaster control area;
- genuinely mobile data users within buildings and campuses, such as engineers at manufacturing plants, hospital staff, or the insurance workforce;
- point-of-sale retail installations where real-time inventory control and manufacturing resource planning are required. In this environment, store layouts change frequently and point-of-sale terminals need to be added during peak sales periods;
- the factory floor where cables can be unsafe and unreliable. In some case, infrared or high frequency narrowband wireless LANs can be used in environments where electromagnetic interference caused by wired LANs can be critical (for example, steel mills and car factories).

Year	1991	1992	1993	1994	1995	1996	1997	CAGR 94-95	CAGR 96-97
Wireless LAN									
Shipments (1,000)	0.0	0.5	8.7	29.7	104.6	312.5	795.0	252	154
Revenues (Million ECUs)	0.0	0.4	7.8	22.9	64.3	149.3	299.2	181	100

Table 15
Total Wireless LAN Market, 1991-1997

The arguments used to support wireless LANs, along with cabling cost and historical building restrictions, include the following:

- The networking investment with wireless is transportable, whereas investment in cabled networks is usually a lost investment when a company or division moves to a new location.
- Wireless LANs are useful for networks that are physically re-routed frequently, accommodating a dynamic work environment and reorganisation of the major LAN users. If networks are wireless, the cost of changes is reduced.
- Installing network cable can present particular problems in certain building constructions, especially older buildings where dangerous materials have been used or where planning restrictions limit the feasibility of installing cable.

DECT has some advantages for wireless LANs because its connection-orientated architecture makes it appropriate where wide coverage is needed or security essential. It should also benefit from substantial economies of scale resulting from the development of DECT chipsets for high-volume cordless telephones. The lower cost difference between a DECT wireless and a wired LAN will result in a higher acceptance of wireless LAN technology. It will, however, take some time before the standards are accepted by the entire community so delaying acceptance of the technology.

The growth will be dramatic with the wireless LAN market in Europe expected to grow at a CAGR (Compound Annual Growth Rate) of 150 percent in revenue and 210 percent in connections over the forecast period. These very significant increases are expected to be fuelled by the ratification of frequency allocations and interoperability standards for the different technologies. The wireless LAN market is therefore expected to grow to about 300 million ECUs by 1997 from 7.8 million ECUs in 1993.

4.1.3. The Ubiquitous Computer

The computer has reached the desktop of 35 million professional workers throughout Europe, yet few computers have made it into the pocket of these workers. Cellular phones show the opposite trend, taken up by an increasing number of mobile workers, and seen as indispensable by many. The crazy thing is that a significant number of these mobile voice transactions would be more efficiently be handled using mobile data and a computer.

An example of this greater efficiency is the travelling salesperson who uses a cellular phone to find directions to the next call. It would be better to have a display in the vehicle with concise directions. This would save the wait while someone worked out the next call and the directions required. This could save large amounts of money as has been demonstrated in a number of our case studies.

Figure 14
European Wireless LAN Forecast Shipments

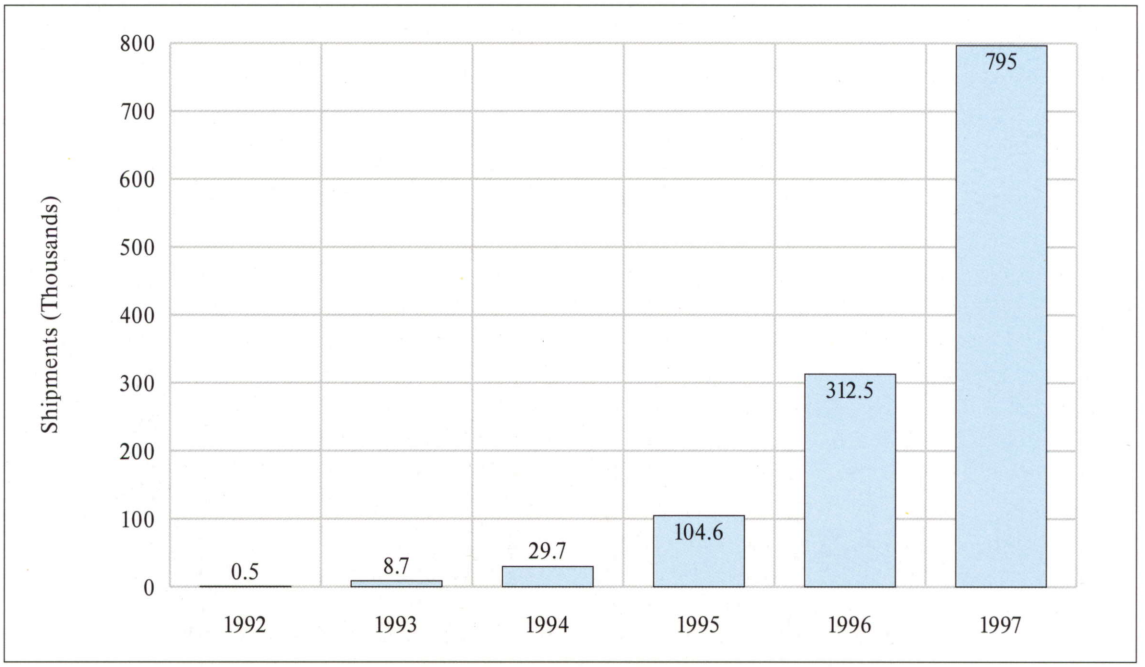
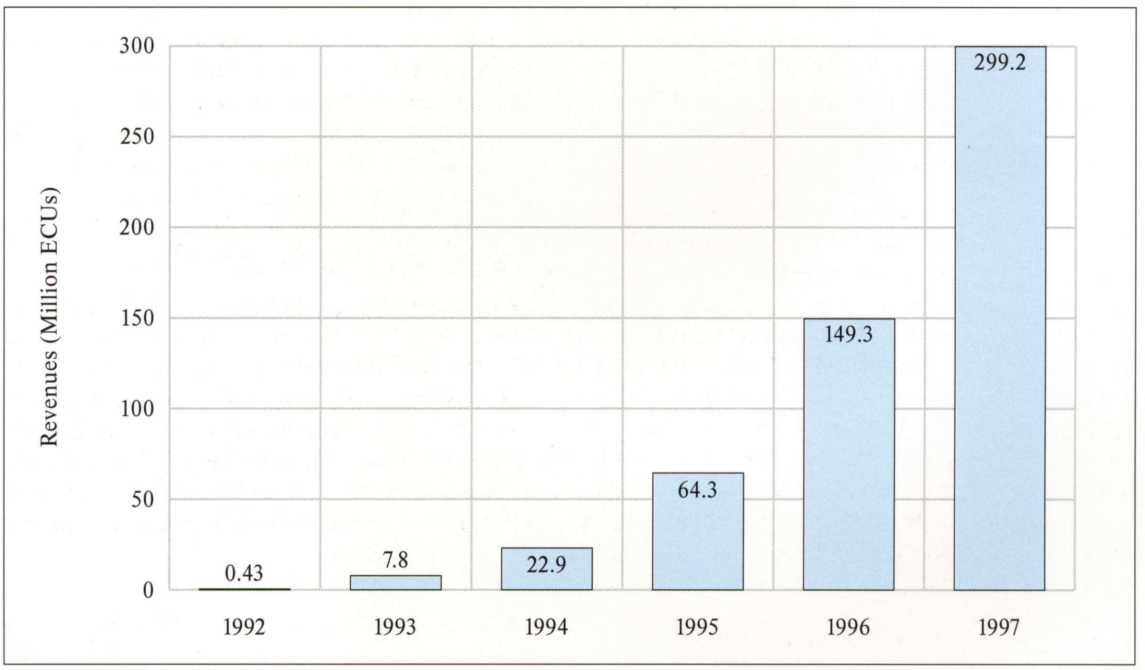


Figure 15
European Wireless LAN Forecast Revenues



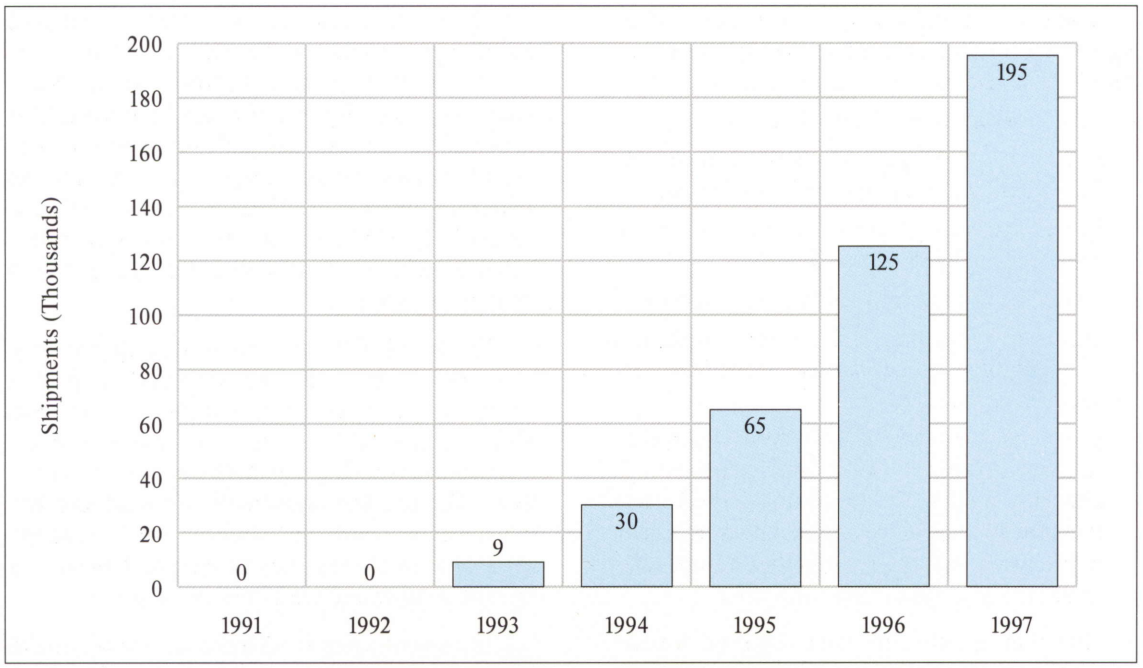


Figure 16
European PDA
Forecast Shipments

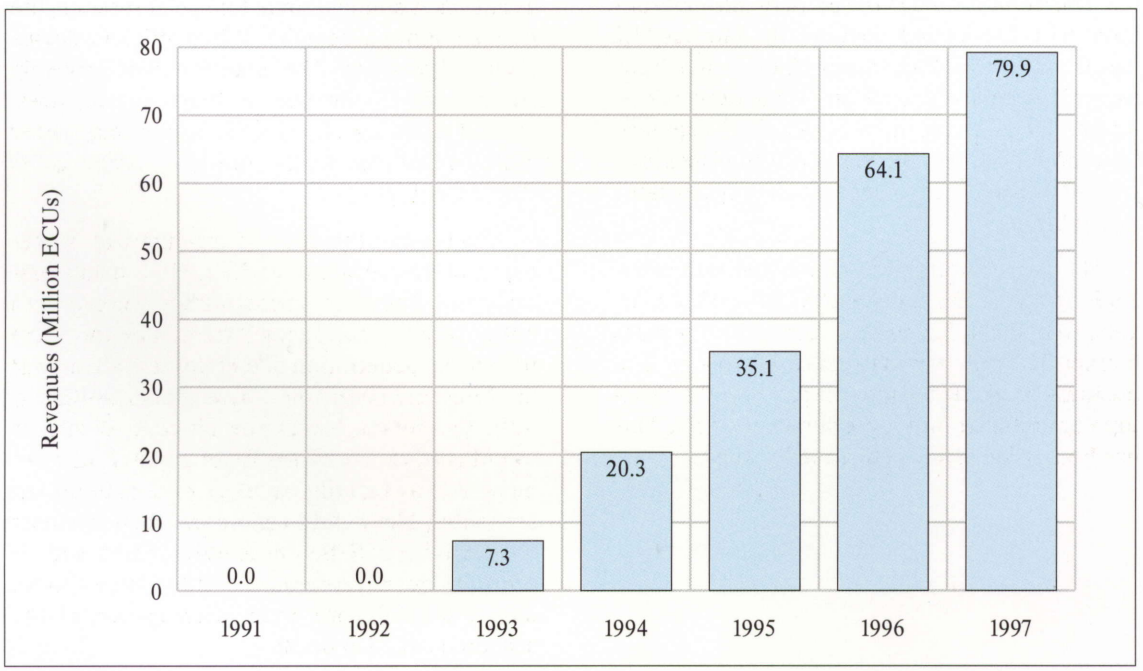


Figure 17
European
PDA Revenues

The saving of money is just one aspect of the advantages of adding a mobile computer with a data link. These can be summarised as:

- up to the minute information;
- access to files and information from the home base such as maps or parts information;
- better accuracy because of the removal of rekeying and instant verification;
- faster job completion and better response;
- connection with base allows use of technical or marketing advice available from base personnel schemes;
- greater security since data can be encrypted to make it more immune from tampering. It also lessens the likelihood of car theft since the generic mobile phone has been replaced with some company specific equipment, making it less valuable to the thief.

However, a data link isn't required for the handheld computer to become part of business life. The trend started in the point of sale environment with Marks and Spencer, the famous UK based clothes to food retail chain, when they used a handheld computer in 1985 to prevent credit card fraud. These point of sale (POS) applications provide one of the most fruitful places for a handheld computer to become as indispensable as the biro.

Yet, it is doubtful, in spite of the numerous applications of these computers in vertical markets, that the volumes can turn it into a mass market. The only way is to make it into a general business productivity tool on par with the desktop computer or into a consumer product. This has been tried today with varied success.

The current state of the art for a keyboard based, consumer pocket computer is the organiser or handheld games console. The handheld games console with an estimated 7m units sold in Europe in 1993 is now a significant consumer product. It proves that a computer can be accepted as a ubiquitous product. The Organizer market at under 500,000 units shows that the market isn't ready to take a pocket computer as a business productivity tool.

The tool is evolving, however, and it is only a matter of time before some sort of pocket computer becomes an accepted business tool. This is expected to be using a pen-based computer with fax modem and mobile phone shaped like a filofax. The combination would use the machine to send and receive fax, exchange electronic mail messages or upload data from a remote mainframe while on the move.

The use of a pen as an input device will make it easy for the computer phobic to use it. This isn't as silly as it sounds, since for social reasons, the pen is a more acceptable if less efficient device than a keyboard. The machine will probably come with all the normal organizer features, such as To-do List, Diary and Phonebook, as near alike as possible to the physical filofax given the technology.

We believe this type of product will be become more prevalent as the mobile data infrastructure becomes more widely spread and better known. The driving force behind this is the increasing penetration of electronic mail (email) in European companies. This works brilliantly until the person leaves the office, and then is out of contact from their fix of email. If this can be solved by carrying an electronic mail pocket computer, like a data cellphone, then business productivity can be measurably improved. If both the pocket computer and the base system have diary software, then interrogation of the schedule can also occur.

The standardisation on the transmission of pen-created messages known as "ink", which will occur in the mid to late 90s, will make it possible for the system to be more than a filofax, one example being the creation of an electronic Post-It note (E-Pin) machine. The E-Pin would act just like a normal Post-It note of today. For example, you receive a message for someone while they were out. You scribble the note on the yellow paper with their name and attach it to the person's computer screen. In the E-Pin world you would follow the same procedure expect that the E-Pin would recognise the name and route it electronically to the person's email box. The email system would be clever enough to route this automatically to wherever the receiver was, if necessary alerting them to a new and urgent message. The receiving person might not have an E-Pin or even an email box, in which case the system would know to fax the message.

These E-Pins will first start off expensive (around 1,000 ECU) and large like the original cellular phones, but even today's technology can nevertheless make them very portable. The prices will drop as the volumes increase, but also like mobile phone services, it is the connection and data handling charge that makes the profit, not the initial hardware. This will put more pressure on hardware manufacturers to produce smaller and cheaper products.

People, however, will still want to communication using voice and the lowering cost of mobile phones will lead it to become a personal device. This leads to the combination of the E-Pin and a mobile phone into the portable communications device of the future. This merging of the computer and the phone will lead to many benefits for the user. For example no longer will you need to remember a phone number, you just look up a name in the phone book and press the "dial" button. If you set the country then the correct country and area code will be added to the number and it will also be possible to cost the call. These might seem trivial advantages but when combined with the functionality of the E-Pin, you have the personal communicator of the late 90s. Everyone will want one.

Year	1991	1992	1993	1994	1995	1996	1997	CAGR 94-95	CAGR 96-97
Analog									
Shipments (1,000)	1,480.5	1,659.2	1,593.8	1,246.5	970.7	762.6	580.8	-22	-24
Revenues (Million ECUs)	2,172.6	1,850.1	1,253.0	796.2	526.8	359.7	242.3	-34	-33
Subscribers (1,000)	4,678.0	5,857.4	6,845.6	7,350.8	7,482.3	7,270.9	6,693.3	2	- 8
Digital									
Shipments (1,000)	0.0	170.7	866.5	1,688.0	2,637.9	3,672.1	4,677.0	56	27
Revenues (Million ECUs)	0.0	164.3	871.5	1,488.9	1,770.3	2,085.2	2,211.9	19	6
Subscribers (1,000)	0.0	170.7	1,010.6	2,642.1	5,160.9	8,639.7	13,029.5	95	51

Table 16
Total European Cellular Market, 1991-1997

Figure 18
Cellular Market Forecast Subscribers, 1991-97

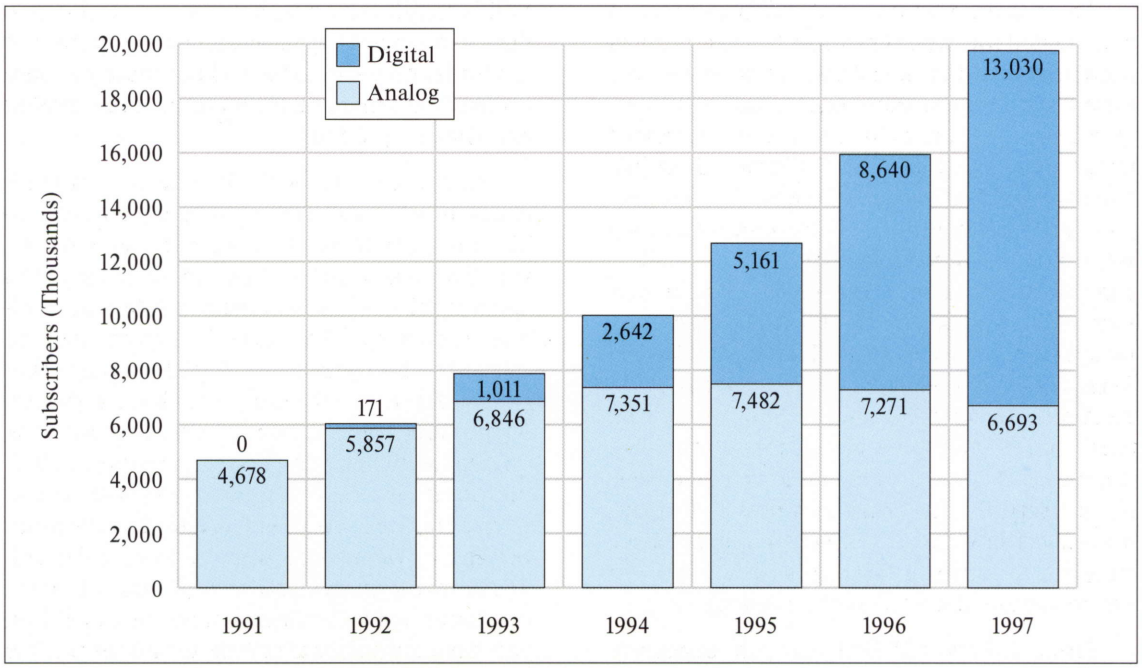
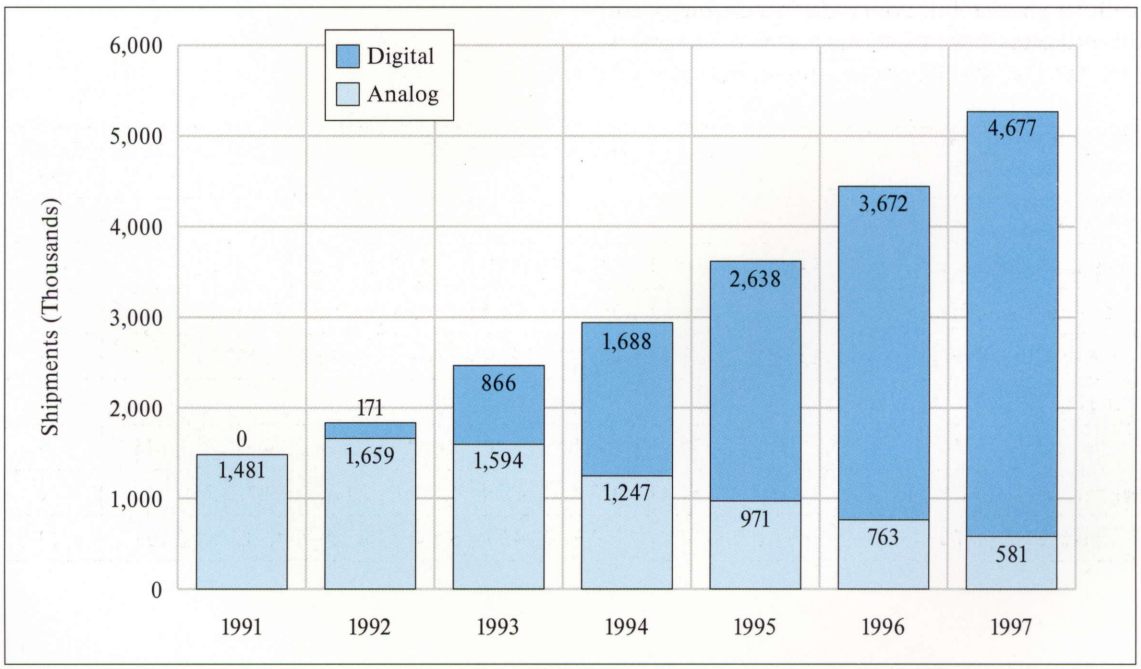


Figure 19
Cellular Market Forecast Shipments, 1991-97



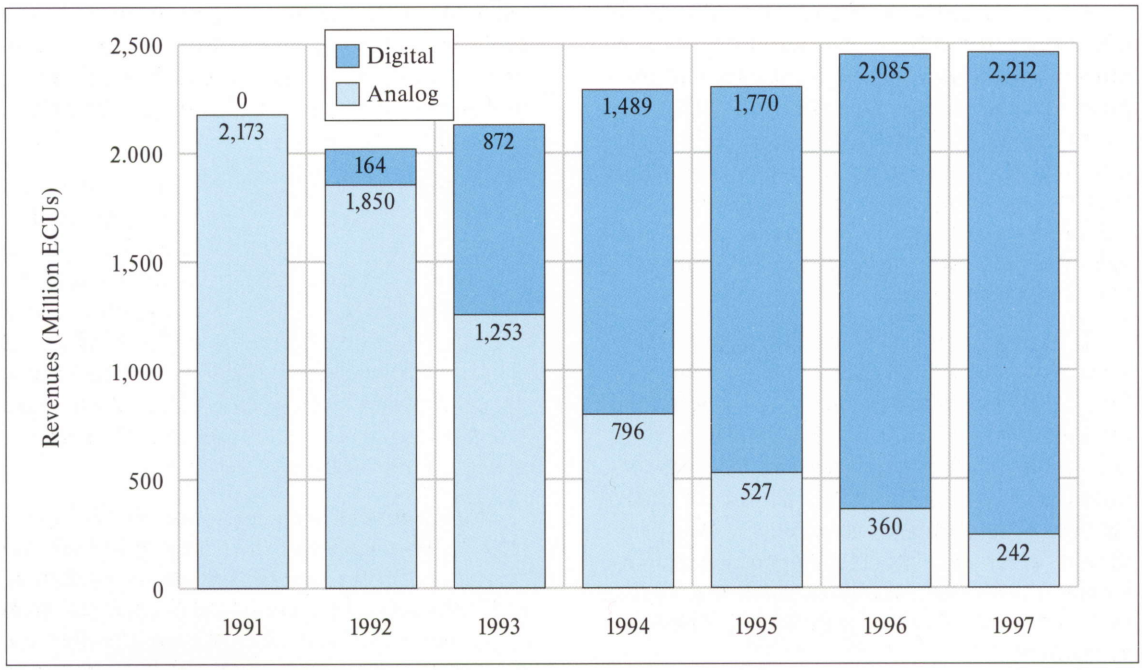


Figure 20
Cellular Market Forecast Revenues, 1991-97

4.2. Barriers to Progress

The barriers to progress to the market of the future where communications and computing merge are numerous. They revolve around five major areas:

i. standards;

ii. frequency allocation;

iii. infrastructure;

iv. cost/performance;

v. user acceptance.

In each of the industries covered, a different situation presents itself which can vary by country. It is therefore difficult to paint a general picture of all the barriers in each market.

4.2.1. Standards

One of the biggest inhibitors is the number of competing standards in every area of mobile computing and communications. This makes each market smaller and so drives costs up while confusing the consumer. The UK, for example, now has three cellular technologies for voice communications and at least 10 separate tariffs. If you have that number of standards for something as simple as voice, then it is no wonder users are confused about the choice for mobile data.

Mobile data, the heart of any of the new products such as the E-Pin, demands many more standards in such things as:

- computer hardware;
- operating system software;
- communications hardware;
- communications infrastructure.

In all of these the standards are lacking or will not support the type of product envisaged. The most well known standard in the personal computer market, for example, is the IBM PC compatible de-facto standard. Unfortunately it cannot support the sort of handheld devices with the current technology. This means that a new standard needs to be established for these devices, even if based on the PC compatible platform, which will take some time.

The software required to drive such a system is at an early stage of development with many of the companies worrying more about perfecting the technology rather than compatibility. There is some hope, though: a large number of software developers have now standardised a format for "ink". The standard, cunningly named, "Jot" should result in an interchange mechanism for the contents of a scribbled electronic Post-It note between directly connected, dissimilar computers.

The computers must be directly connected because any other connection will result in a choice of communications mechanism. This can range from paging through to a HiperLAN 100 Mbit link, all incompatible, all with their own advantages and disadvantages. If this could be treated without user intervention, then it would be a manageable problem, but because the hardware and infrastructure is so vastly different, they need to make a choice. If that wasn't bad enough, the format for data message transferral across these platforms remains an unsolved mystery.

4.2.2. Frequency Allocation

One of the most important and complex factors determining the implementation and success of new wireless communications products and services is the allocation of frequencies to support them. The amount of radio-frequency allocated and its location in the electromagnetic spectrum is key in determining the capacity and capabilities of wireless communications offerings. For service operators, the frequency available relates directly to the cost per subscriber and hence to the types of service offered and the tariffs charged.

Radio-frequency has become a valuable commodity, sought after by the military, communications operators and broadcasters alike. Historically in Europe, spectrum has been allocated at a national level, international co-ordination under the auspices of bodies such as the WARC and CCIR resulting in largely voluntary agreements. Local requirements and political emphases have often led to different solutions in both spectrum allocation and technology choices.

Pan-European standards such as GSM and DECT, have involved new programs with co-operative efforts to agree frequencies, backed up by Community directives to set them aside. Such programs should benefit European suppliers, operators and consumers by promoting common standards for roaming and economies of scale. A possible drawback is the time it takes to agree such allocations, requiring as it does the input of many interested parties within a number of countries.

4.2.3. Infrastructure

The cost of introducing new mobile technologies is enormous because of the infrastructure needed to support it. Mannesmann have spent around 4.5 billion DM constructing their new Germany-only GSM network. This vast expense makes the rollout of these technologies slow, especially when liberalisation has yet to hit all markets within Europe. This puts pressure on the data-only networks when the major use for mobile communications is voice. We therefore believe that a European-wide mobile data network will not happen in the short-term.

This means that the companies installing wide area mobile communications are concentrating on voice rather than data. They, for example, will use their marketing money to subsidise the handsets to acquire voice customers. This is in spite of the relatively small cost of laying a data network over the voice infrastructure. One of the reasons for this is that the average length of a voice call is nearly ten times as long as the average data call. This results in less revenue for the network operator and worse utilisation of the network for data.

4.2.4. Cost/Performance

The cost and performance of the mobile computers and their wireless networks need to be affordable. This is best shown in the wireless LAN market where the prices remain significantly higher than wired solutions and performance significantly lower. For example, the average wireless LAN costs over twice as much per node while having as little as one third of the performance.

The same cost versus performance puzzle applies to mobile voice communications but this has been overcome by new uses. These uses for mobile data devices are less obvious and just starting to appear as the cutting edge of technology reaches the market. The cost, however, for most people is too high just as the mobile phones were in the mid-80s. This will stunt the growth but not alter the long term future of the market.

4.2.5. User Acceptance

The highest penetration rates for mobile phone and data technology are in Scandinavia because they started first in both mobile voice and data markets. This should make Scandinavia the hotbed for the new era of mobile data, yet this isn't so. It is true that there are a larger number of vertical markets than elsewhere in Europe but that hasn't lit the fire under the market.

We believe that users do not perceive a need for this technology or have an appreciation of what it can do. This demands that seeding and educational projects need be undertaken. It also demands technology that produces a product that people want to buy. We believe that the product will only sell into the consumer market if it can be seen to be:

- Work *anywhere*. This means that it must work both inside and outside of a building, and over most of the country. In technical jargon, good penetration and broad coverage.
- *Reliable* so that 95% of the time it will work.
- Demonstrable so that someone *will want* to buy it.
- Affordable so that someone *can* buy it.

We are a long way off that for the present because of both technical, infrastructural and political reasons. This makes the business market the most likely prospect in the short term. Communications vendors must, however, examine the customer's business to find out what problem the technology can solve. This is a slow process that has only recently been embarked on. This search will be helped by the increasing spread of local area network and electronic mail that has brought the electronic enterprise nearer.

4.3. The Impact on the Non-mobile Environment

There is some evidence to suggest that the use of portable telephones may eventually take over from fixed telephones for personal communications. In Finland for example, Telecom Finland claims that it now has the highest penetration of mobile telephones at around 10% while at

the same the rate of growth of subscribers to its cellular network continues to accelerate. This suggests that the convenience of use of a portable phone is such that people prefer to use them rather than wired phones. However, Telecom Finland also claims to have the lowest tariffs for the use of mobile phones.

Logically, this seems to suggest that as the cost of using mobile phones falls to equal that of using fixed phones, they will become the preferred method of communications. Also as the number of users of mobile networks increases a critical mass will be reached at which point traffic from mobile to mobile will exceed that between mobile and fixed phones.

Whether the same arguments will apply to data communications, however, is debatable, since for the present and immediate future, most data calls will be between a mobile terminal and a fixed host computer. We therefore believe that for the present mobile data communications systems are unlikely to have significant impact on non-mobile services and systems.

5. Methodology

Government statistical bodies tend to model the world starting with the system of national accounts. Agreed classifications for industrial activity and trade thus become the measures against which markets are assessed. In many areas the restrictions imposed by such classifications and by the rigorous methods used to collect and process information are too great to make the resulting information useful to the business community. The IT market is a case in point, and the failure of the standard classifications to get to grips with the subject of software is a specific limitation.

The basis for this study is the marketplace. Thus, instead of defining the marketplace in terms of what is produced plus the balance of trade, Dataquest's research is aimed at measuring the market. Valuation is based upon the revenues paid to primary vendors with research results cross-checked against a continuous programme of quarterly surveys, end-user interviews and distribution channel monitoring. Data on trade flows has also been collected, and matched as closely as possible to Dataquest's market oriented segmentation, since these data can tell us things about the position of Europe with respect to the world.

5.1. Definitions

Dataquest segments European cellular telephones by technology according to the following definitions:

- *Analog:* This is equipment conforming to all analog cellular standards in operation in Europe. In cases where more than one analog standard is supported by the country's network operators, market data for all analog systems has been combined in that country's tables.
- *Digital:* This is equipment conforming to the pan-European digital cellular standard GSM and its derivative DCS-1800.

Dataquest has segmented the personal computer market in numerous ways, however, the only definitions that apply in this chapter are:

- *Notebook:* Battery-powered computer that is typically the size of a small telephone directory (A4 size: 8.5 x 11 inch or European A4) and weighs less than seven pounds with the battery. It is typically compatible with, and has computing power equivalent to, desktop personal computer systems.

- *Subnotebook:* The subnotebook is similar to the notebook, but is lighter and does not have an internal floppy disk drive. They are lightweight, typically four pounds or less, battery powered units that can be carried easily from place to place.
- *PDA:* Personal Digital Assistant that weighs between 450 g to 900 g, and uses a pen for the user-interface. It must have an operating system that uses sophisticated handwriting recognition and personal information management applications which can share data.

Dataquest calculates shipments of cellular phones and wireless LANs as new products sold either directly to end-users or leased for the first time during the year in question.

Dataquest calculates (Total End-User) Revenue in the cellular markets as the product of the number of shipments of each product model falling into a particular category, multiplied by the manufacturer's estimated end-user selling price, whether or not products were sold directly to end-users or to leasing organisations. These are calculated in local currency, converted into US dollars and finally converted into ECU at the average 1992 exchange rate of 1 ECU to $ 1.29.

A different situation exists in the United Kingdom where prices to end-users have been significantly lower than in any other territory in Europe, and often lower than the manufacturer's production costs. To a large extent, this is due to the distribution set-up for services in this market, whereby airtime retailers give large discounts to end-users, or bonuses to dealers on initial equipment sales, in order to maximise revenue from call charges. In this case, Dataquest counts both the amount paid by the end user, and the average amount paid by the airtime retailer in connection bonuses or equipment discounts, in calculating the selling price of any given model.

In the wireless LAN and personal computing arenas, the prices and hence the revenues are based on end-user spending. These are calculated by assessing the volume of units sold to the end-user segments Dataquest defines, and applying an appropriate discount structure off the list price. The volumes therefore equate more closely to the actual amount of money spent by end-users.

The countries used for the personal computing market data and forecasts are:

France, Germany, Italy, the Netherlands, Spain, Sweden, the United Kingdom, Belgium, Denmark, Finland, Norway, Switzerland, Austria, Greece and Portugal.

In addition, for the cellular and wireless LAN markets, Turkey and other smaller principalities are included.

6. Glossary

Antenna The element from which a radio transmission is radiated and through which transmissions are received.

Base Station A fixed radio transceiver in a cordless telephone system, mobile radio or cellular radio network.

BTR Basis for Technical Regulation.

C-450 Analog cellular standard employed in Germany and Portugal.

CAI Abbreviation for Common Air Interface, a definition of the technical parameters of control and information signals passed between a radio transmitter and receiver such that intercommunication may take place between equipment manufactured by different companies. Normally associated with CT2.

CCIR Abbreviation for Comité Consultatif International des Radio-Communications (International Radio Consultative Committee), now defunct. Until March 1993, the main body within the International Telecommunications Union and responsible for defining and recommending technical standards for radio operations and equipment (see also TSB).

CCITT Abbreviation for Comité Consultatif International de Téléphonique et Télégraphique (International Telegraph and Telephone Consultative Committee). Now defunct. Until March 1993, the main body within the International Telecommunications Union and responsible for defining and recommending technical standards for telecommunications operations and equipment (see also TSB).

CDMA Abbreviation for Code Division Multiple Access, a method of using spread spectrum (q.v.) radio technology that allows a number of simultaneous data or voice communications to share the same communications medium by allocating each conversation by coding each conversation using an encryption key known only to the corresponding terminals for the duration of their conversation.

Cell The area covered by a single fixed transceiver in a cellular radio network. It may vary in size from 0.5 km to 30 km radius depending on the anticipated density of users.

Cellular Radio A method of increasing the number of simultaneous radio conversations that can be supported by a fixed number of radio frequency channels by limiting the range of transmitters to a single cell to which a proportion of the available channels is allocated. Adjacent cells are allocated a different set of radio frequency channels to avoid interference or blocking of conversations. Frequencies can be reused in cells at intervals sufficient to avoid interference.

CEPT Abbreviation for Conférence des Administrations des Postes et des Télécommunications (European Postal and Telecommunications Conference). A body established in the 19th Century by PTTs (q.v.) to account for and divide revenues generated by international postal, telegraph and telecommunications traffic, and to define commonly acceptable technical standards.

Channel In the context of radio communications, a band of radio frequencies of sufficient breadth to contain a voice or data signal transmitted in one direction.

Cordless telephone A telephone for use with the PSTN comprising two separate components – a portable handset containing microphone, loudspeaker and dial keypad and fixed base PSTN access unit – which are interconnected by a radio link rather than a wire.

CT2 Second generation (hence the 2) of Cordless Telephone (CT) based on digital radio technology.

CT3 Third generation cordless telephone that evolved into the DECT standard.

CTR Common Technical Regulation.

DCS-1800 Digital Communications System at 1,800 MHz. A specification for digital cellular radio systems conforming with GSM (q.v.) network architecture and radio interface, but operated at the higher frequency of 1,800 MHz, and with a lower maximum limit on fixed and mobile transmitter power output. Adopted as a pan-European standard for personal communications networks.

DECT Abbreviation for digital European cordless telecommunications system. A technical specification for wireless LANs or telephones. A pan-European standard that is to become a Common Technical Regulation (q.v.).

Duplex channel A two way radio communication whether for voice or data where a simultaneous transmission and reception is required, and occupies two separate channels, or a duplex pair, one for each direction of communication.

ERMES Abbreviation for European Messaging System, a pan-European digital radio paging system.

ETS European Telecommunications Standard.

ETSI Abbreviation for European Telecommunications Standards Institute, a standards-making body.

FCC Federal Communications Commission. A Federal Government agency responsible for regulating and administering all communications in the USA.

Frequency Band A range of frequencies defined and dedicated to a particular type of service or radio technology. A frequency band is usually subdivided into a number of channels.

Frequency hopping A technology that allows a number of simultaneous data or voice communications to share the same communications medium by causing transmitting and receiving stations to change the frequency rapidly in a pseudo random sequence among a large number of discrete radio channels. Synchronisation of transceivers is achieved by making them follow a hopping sequence calculated from a predefined algorithm. The hopping sequence can be dynamically adjusted to avoid other transmissions or interference taking place in the same band of frequencies.

GSM An abbreviation for Global System for Mobile communications, a digital cellular telephone technology defined by the Groupe Speciale Mobile of the CEPT as a pan-European standard.

Hand-Off The process of passing a cellular telephone call from one cell to another as the user of a mobile telephone traverses several cells during the course of a conversation.

IETS Interim European Telecommunications Standard.

Infrared Electromagnetic radiation at wavelengths just longer than those of visible light, generally in the range 860 to 2,000 nanometres, and used for free space and optical fibre communications.

Inmarsat International Maritime Satellite – the organisation responsible for launching and operating satellite systems to provide communications services for ships at sea, and for some specialised terrestrial applications.

IR An abbreviation for Infrared (q.v.).

ISA Abbreviation for Industry Standard Architecture. The expansion bus in the IBM PC AT and subsequent PC compatible computers.

ISDN Abbreviation for Integrated Services Digital Network. A digital way of connecting to the wired telephone system.

ISM An abbreviation for Industrial, Scientific and Medical, a range of frequencies allocated for general purpose use by industrial, scientific and medical equipment such as microwave ovens, medical probes, moisture measuring equipment etc., for which no operating licence is required. Wireless Local Area Networks (WLAN) will operate in this band, using Spread Spectrum technology to avoid mutual interference with other equipment. In Europe, a band of frequencies around 2.45 GHz to 2.5 GHz is designated for ISM and WLAN applications.

Linear Modulation A technology that reduces by 50% the channel width required for a voice or data communication between two way mobile radios.

MAP27 A technical standard defining a physical and logical interface to allow a computers or other data terminal equipment to be interconnected with a mobile radio transceiver.

MODEM Abbreviation for MOdulator-DEModulator – an item of terminal equipment that encodes and decodes a digital data signal as a series of audio frequency tones suitable for transmission over the PSTN (q.v.).

MoU An abbreviation for Memorandum of Understanding, a document signed by a number of organisations setting out their commitment to achieve a common goal such as the mutual adoption of technical standard.

NET Norme Européenne pour Télécommunications (superseded by BTR and CTR).

NMT-450 The Nordic Mobile Telephone (NMT) standard at 450 MHz. This was the original specification for an analogue cellular telephone developed to serve the four Scandinavian countries.

NMT-900 The Nordic Mobile Telephone (NMT) standard at 900 MHz. This was the specification that succeeded NMT-450.

NMT-F A French variation on the NMT-900 standard.

Packet radio A radio communications system dedicated to data transmission in which data messages are divided into packets prior to transmission to ensure compatibility with existing packet switched networks (q.v.) and to increase the data carrying capacity of a given radio channel by allowing packets from different data conversations to be interleaved.

Packet Switched Network A data communications network where data are divided into small segments known as packets in such a manner that each packet forming part of a complete message may be routed to its destination independently of all other packets forming the same message though a network of switches. See also X.25.

PAD Abbreviation for Packet Assembler Disassembler, a device for converting a digital data signal into segments known as packets prior to transmission through a packet switched network and for converting received data packets back into a form suitable for processing.

PAMR An abbreviation for Public Access Mobile Radio.

PAP Public Access Profile, a definition of the technical parameters of control and information signals passed between a radio transmitter and receiver such that intercommunication may take place between equipment manufactured by different companies. Normally associated with DECT.

PBX Abbreviation for Private Branch Exchange.

PCMCIA Abbreviation for the Personal Computer Memory Card Industry Association. A voluntary body that has produced a specification for memory cards and peripherals that plug into small computers.

PCN Abbreviation for Personal Communications Network.

PDA Personal Digital Assistant, a pen based hand-held computer with handwriting recognition.

PMR An abbreviation for Private Mobile Radio.

Private mobile radio Two-way radio systems where communications is allowed only between users belonging to the same company or organisation to whom a dedicated radio frequency channel is allocated by a national licensing authority.

PSTN Abbreviation for Public Switched Telephone Network, the normal phone system.

PTO Abbreviation for Public Telecommunications Operator, a privately owned company licensed to operate a public telecommunications network. See also PTT.

PTT Abbreviation for Posts, Telegraphs and Telecommunications administration – a government department responsible for running national telecommunications and postal services usually as a monopoly.

Public Access Mobile Radio A two way radio system which may be used by many different organisations sharing a number of radio frequency channels, but who are allowed only to communicate with members of their own organisation, and with the operator of the radio network. See also Trunking.

Radio PAD A packet assembler-disassembler (q.v.) with an integrated radio transceiver for use with Packet Radio systems.

ROA Abbreviation for Recognised Operating Agency, the ITU nomenclature for a telecommunications or radio network operator whether PTT, state owned corporation or privately owned company.

Roaming The ability of a mobile phone or mobile data terminal to connect with networks of the same technical specification but owned and operated by different network operators, either within one country or across national boundaries.

RTMS Analog, quasi-cellular system employed in Italy.

SIM An abbreviation for Subscriber Identity Module a programmable non volatile memory in a portable or mobile telephone conforming with the GSM or DCS1800 standards, that contains codes to identify a subscriber to a digital cellular telephone service and details of special services the subscriber has elected to use. It may be fixed within the phone, or more commonly take the form of a removable smart card.

Smart Card A plastic card in which is embedded a memory and processor chip.

SMS Abbreviation for Short Message Service a feature of the GSM European digital cellular telephone system that allows short text messages to be transmitted from and received by mobile telephones.

Spread Spectrum A radio technology that allows a number of radio communications links to use the same band of frequencies simultaneously without mutual interference. Individual two-way conversations may be separated either by CDMA or Frequency Hopping (q.v.) multiple access techniques.

TACS Abbreviation for Total Access Communications System, the technology used to implement analogue cellular telephone networks in the United Kingdom.

TCP/IP Abbreviation for transmission control protocol/Internet protocol. The standard means of communications between two UNIX type computers.

TDD An abbreviation for Time Division Duplex.

TDMA Abbreviation for Time Division Multiple Access, a technology that allows a number of simultaneous data or voice communications to share the same communications medium by allocating each conversation in sequence a small period of time known as a time slot.

Telepoint A cordless telephone base station placed in a public place so that owners of compatible cordless telephone hand-sets may make calls on paying a fee.

TETRA An abbreviation for Trans European Trunked Radio Access, a pan-European digital trunked radio system designed to support both voice and data communications.

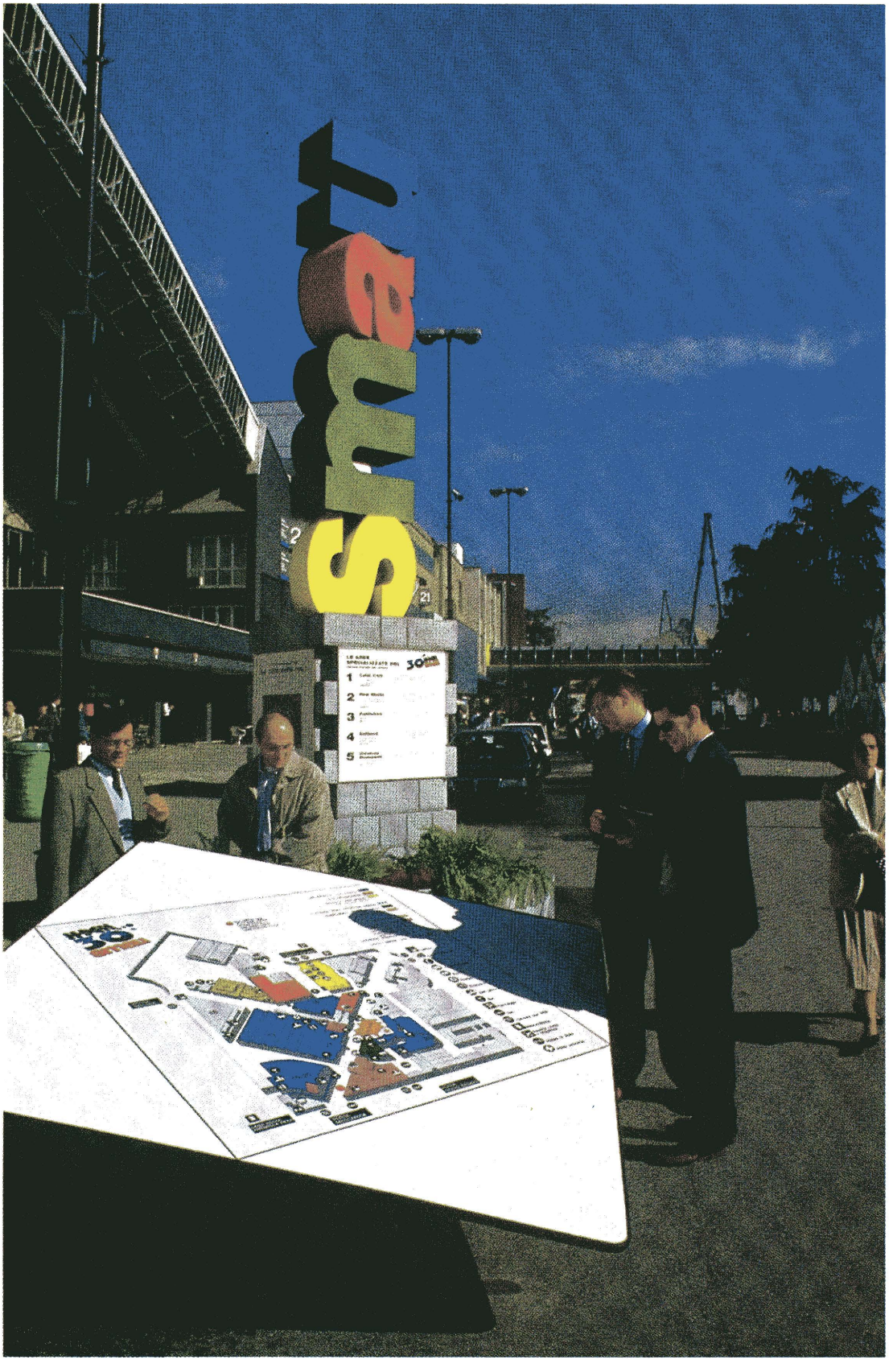
Time Division Duplex A technology allowing use of a single channel for a two way digital voice or data communication by dividing a conversation into a series of small time slots so that alternate time slots may be allocated to the two directions of transmission. For voice, data in each time slot is compressed to half its natural duration prior to transmission and expanded by the receiver so avoiding loss of information. The technique is used in CT2 and DECT systems.

Trunked radio network A radio network operated for the benefit of closed groups such as haulage fleets, and which uses trunking techniques to increase capacity and reduce costs.

Trunking The allocation of a radio frequency channel to a mobile radio user for the duration of each conversation rather than on a permanent basis, so allowing a given radio channel to be shared among a number of users.

TSB Abbreviation for Telecommunications Standardisation Bureau, formed in March 1993 as the main body within the International Telecommunications Union responsible for co-ordinating the definition and ratification of technical standards and recommendations for telecommunications and radio communications.

X.25 An international recommendation defining a standard for the software interface and protocols to be used between a data communications network over which data is carried as packets, and a data terminal equipment.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The Information Technology Market in Europe's Public Administrations

This paper has been provided by NOMOS RICERCA in close cooperation with the EITO Task Force. For definitions see section 4.7. Methodology of this paper.

1. Introduction: Structural Background

The early 1990s have witnessed sweeping economic, political and social transformations worldwide and, above all, in Europe.

Against this background of profound structural change, a number of countries have been reviewing their policies with regard to their public administrations, which is being assigned an important new role in the general move out of the recession.

Demand for better-quality services and cost rationalisation in the public sector and an awareness of a new relationship between national competitiveness and an efficient public administration are key factors in today's new plans to reengineer the public sector with a view to improving service and process quality.

Generally speaking, the policies of the 1980s, based on a precarious balance between the concepts of laissez-faire and welfare state, are being replaced by a new approach to the role of the public administration. Despite significant differences, this trend is emerging both in Europe and in the United States.

The new policies of the European public administrations focus on a number of key issues: the quality of services and a consequent improvement in public-sector competitiveness; reorganisation of internal processes through unification, streamlining, elimination of duplications and inter-departmental integration; transparent procedures and cost rationalisation; retraining of staff at the various hierarchical levels through empowerment mechanisms; introduction of management control systems and market tests.

Information technology (IT) and telecommunications are essential tools for the renewal of public administrations.

In the USA, the important role played by information technology in President Clinton's economic programme, which establishes a close link between National Performance Reviews and National Information Infrastructures, will lead to significant investments in IT and telematics to support change in the public administration.

In Europe, on the other hand, this close relationship between improvements in the public administration and information technology has not yet been established at policy level. European public-sector expenditure is falling, and an increasing proportion of the total is accounted for by current expenditure. Moreover, mid-term projections indicate no sign of a significant recovery. Many countries are curbing IT expenditure in the public sector and this has a negative impact on market demand.

Nevertheless, it is clear that the re-engineering process favoured by all European countries

depends on major investments in technology and that public administration is potentially a very important area for the introduction of innovations designed to boost efficiency and improve service quality, stimulating growth of the market as a whole.

The purpose of this report is to assess the current situation and IT market trends in the public administration of a number of European countries (United Kingdom, Germany, France, Spain and Italy) until 1995; to analyse IT diffusion and propensity to spend in the different countries; to assess the impact of change in the public administrations on IT demand; to analyse the role of the authorities responsible for controlling and planning computerisation in the public administration.

2. EU Policy and Action as Regards Computerisation of Public Administrations and Creation of Supranational Infrastructures

To date, the European Community's strategy with regard to the public sector has been geared to resolving urgent matters arising from the creation of the Single Market through standardising action. As a result, solid communication networks have been created in the individual departments of the public administration. But since action has not always been uniform, interoperability is low.

The coming into force of the Treaty of Maastricht requires "the interconnection and interoperability of national networks and access to such networks" (Clause XII).

The Commission (Com (93) 69 def. of 12. 3. 1993) has submitted a set of guidelines to the Council of Ministers for a trans-European telematics network linking public administrations.

EU action focuses on the following projects of common interest:

i. abolition of controls at intra-community borders and tighter controls at external frontiers, management of statistical data, fight against evasion, mobility of people and indirect taxation;
ii. full implementation of the four freedoms of movement stipulated in the Treaty of Rome (goods, services, people and capital);
iii. creation of support for EU policies on agriculture, the environment, competition and structural policies (fishing, energy ...);
iv. implementation of a Community decision-making process involving not only all EU institutions and bodies but also the administrations of the member States.

To support these projects, the Commission has proposed to the Council that a long-term programme (Interchange of Data between Administrations, IDA) be set up, under which feasibility studies can be conducted and telematics networks linking public administrations developed.

The IDA programme will take account of the results of previous community projects (CADDIA, INSIS, TEDIS, ENS) and of all current European standards. Its aim is to contribute to the development of a telematics network among the various administrations. It will operate at two levels:

i. at a sectorial level, feasibility studies will be performed to establish the specific issues to be covered by telematics systems for the exchange of information;
ii. at a horizontal level, common physical-functional architectures will be developed. The first step will be to identify a common denominator for all the administrations involved. The second will be to incorporate the networks in common telematics architectures.

The IDA programme will have a budget of ECU 340 million for a five-year period. It will focus on five priority projects of common interest:

- management of external frontiers;
- management of statistics for intracommunity exchanges;
- management of public security;
- management of free movement of people;
- taxation.

In these five areas, unified telematics networks will be created, interconnecting the relevant administrative departments.

A vital role will be played by the Telematics in Administrations Group (TAG), composed of national directors for public administration computerisation. The TAG's mandate is to provide a permanent interface between the Commission and the member States, to ensure strategic sectorial and intersectorial coordination, and to act as the Commission's advisory committee for the IDA programme.

The Council of Ministers is expected to approve this programme for trans-European telematics networks in public administration in 1994.

3. IT Authorities and IT Policies in the Main European Countries

The question of efficiency and service quality in the public sector is closely related to the debate on the need for a central body to regulate and control computerisation in public administration. Different European countries adopt different approaches, ranging from recognition of public-sector autonomy to centralised control, coordination and planning. All European countries now have a central public Authority responsible for computerisation in the public administration, although the mission, structure and planning and control tools of these Authorities vary.

3.1. France

The French Authority, the CIIBA, Comité Interministeriel de l'Informatique et de la Bureautique dans l'Administration, was formed in 1986 and reports to the Prime Minister. Its jurisdiction covers information technology in central Ministries.

The CIIBA's role is consistent with the French government's policy of granting the public administration autonomy in the management and development of computerisation. It provides guidance and coordination rather than control.

The main functions of the CIIBA are to provide guidance as regards use of information technology, to draw up recommendations on standards and to coordinate interministerial projects. The CIIBA also makes non-binding assessments of Ministries' long-term investment programmes (schémas directeurs) and of the annual budget requirement submitted by each Ministry to the Direction du Budget of the Ministry of Finance.

The CIIBA can finance or co-finance low-cost projects concerning particularly innovative or strategically important applications for the administration. Every year, it draws up a report on the state of computerisation in the public administration and on the main projects and plans which have been examined.

Ex-ante control of contracts is performed by the CCMI (Commission du control du marché informatique), which is part of the CCM (Commission du control du marché).

France has no central procurement agencies for the purchase of products and services.

Common methodologies in the public administration currently cover the definition of schémas directeurs, software development, support for the drawing-up of contracts.

The CIIBA also promotes and recommends use of EU reference standards.

3.2. Germany

Germany's highly decentralised administrative structure, under which the Länder have great functional and political autonomy, has a significant influence over the coordination and responsibilities of the various Authorities.

The KBSt (Koordinierungs- und Beratungsstelle der Bundesregierung für Informationstechnik in der Bundesverwaltung) is the Federal Government Authority. It was formed in 1968 and reports to the Ministry for Internal Affairs. Its jurisdiction is limited to the federal Ministries and concerns both information technology and telecommunications.

The KBSt's role is to provide consultancy, guidance and support as regards IT and telecommunications, standards, interministerial projects. It also controls the federal Ministries' individual long-term IT and telematics investment programmes, projects and the annual budget requirements of the Ministries, based on their long-term programmes; its assessment is binding as regards approval of funds by the Ministry of Finance. In addition, the KBSt draws up annual reports on the state of computerisation in the federal administration.

Apart from the KBSt, a number of other coordination organisations exist in Germany: the IMKA (Interministerieller Koordinierungsausschuß), which reports to the KBSt, and coordinates use of information technology among the Federal Ministries and the State Ministries; the KGSt (Kommunale Gemeinschaftsstelle für Verwaltungsvereinfachung), which acts as a coordinator among local communities; the KooPA (Kooperationsausschuß für automatische Datenverarbeitung), a committee for cooperation among the KBSt, the Länder and the KGSt.

No central procurement agencies exist in Germany for the purchase of IT products and services in the public administration.

To support coordination and control, the KBSt promotes common methodologies for software development and negotiation of purchase contracts.

With regard to standardisation, the technological standards adopted by the EU are recommended.

3.3. Italy

The Authority for Information technology in the Public Administration in Italy, known as the AIPA, was set up very recently (1993) and is part of the Italian Prime Minister's Office.

Its jurisdiction covers Ministries and Central Government Departments.

The mission of the AIPA, as laid out in Law 39/93, is as follows: definition of technical standards as regards planning, implementation, management and security of the administration's information systems; coordination of the administration's IT projects; promotion of intersectorial projects; periodical assessment of use of IT in the administration; definition of guidelines for training of EDP personnel; management of relations with the EU.

The AIPA also draws up the contents, conditions and procedures of the three-year plan, on the basis of the plans of individual departments.

Procurement policies and methodologies to be used in the various phases of the computerisation cycle are still being defined. Recommended standards are in line with EU reference standards.

3.4. Spain

In Spain, control and coordination of computerisation in the public administration is handled by a political body, the CSI (Consejo Superior de Informatica), and an executive body, the CIABSI (Comisión Interministerial de Aquisición de Bienes y Servicios Informáticos), which were formed in 1983. Both units are part of the Public Administration Ministry and their jurisdiction covers use of IT and telecommunications in the central Ministries.

The CSI draws up policies regarding the use of IT and telematics and defines standards.

The CIABSI examines and approves departments' IT and telematics plans and projects and its assessments are binding as regards approval of funds. It also draws up methodologies, handles a significant proportion of IT procurements, selects suppliers, and promotes interministerial projects. Technical and financial approval is required for projects worth more than 15/18 million pesetas.

The central administration's purchases are completely centralised. The CIABSI handles product and services procurements for values exceeding 100,000 pesetas, except those of the Ministry of Defence. Purchases beneath this limit are handled by the Servicio Central de Suministros.

Methodologies defined by the CIABSI cover software development, monitoring, supplier requirements and contractual procedures. Recommended standards are the EU reference standards.

3.5. United Kingdom

The United Kingdom's Authority for information technology in the public administration is the CCTA (Central Computer and Telecommunications Agency), which was formed in 1972 and deals with information technology and telecommunications in Ministries. The CCTA reports to the Treasury.

The CCTA's functions have changed over the years in line with the UK policy in favour of autonomous, privatised central agencies (Next Step Agencies). Initially, the CCTA had mandatory control over civil service departments and defined compulsory common methodologies, which were therefore used by the majority of departments. Today it performs a non-mandatory role as consultant to the public administration.

The CCTA is also responsible for promoting use of information systems to improve government efficiency, supporting interministerial projects, and defining methodologies and standards. To a decreasing extent, it is also responsible for public administration procurements.

The centralised procurements policy (standing arrangements) today covers a decreasing portion of the administration's overall expenditure.

The methodologies drawn up by the CCTA cover the entire cycle of IT project planning and implementation (planning, feasibility studies, software development, monitoring, supplier requirements). The technological standards it recommends are in line with the EU reference standards.

3.6. A Comparison

Each of the countries examined has an Authority for information technology in the public administration (see *Table 1)*. The year of formation, mission and structure of these Authorities differ.

Table 1
The Main IT Authorities in Europe's Public Administrations

Country	Authority	Reports to	Year set up	Jurisdiction	
				Technology	Bodies
France	CIIBA	Prime Minister	1986	IT	Ministries
Germany	KBSt	Ministry of Internal Affairs	1968	IT Telecoms	Federal Ministries
Italy	AIPA	Prime Minister's Office	1993	IT	Ministries
Spain	CSI CIABSI	PA Ministry	1983	IT Telecoms	Ministries
UK	CCTA	Treasury	1972	IT Telecoms	Ministries

Table 2
Areas under the Jurisdiction of the IT Authorities in Europe's Public Administrations

Country	Analyses and reports	Assessment of plans	Assessment of projects	Consultancy	Promotion interministerial projects	Definition methodologies	Projects financing	Management centralised procurements	Definition of standards
France	●	●	●	●	●	●	●		●
Germany	●	●	●	●	●	●			●
Italy	●	●	●	●	●	●	●		●
Spain	●	●	●	●	●	●		●	●
UK	●			●	●	●		●	●

The oldest Authorities are the KBSt (Germany) and the CCTA (UK); the most recent is the newly formed Autorità (Italy).

The missions of the Authorities fall into two main categories: process control and mandatory assessments (Spain, Italy, Germany), and activities of a non-mandatory nature, which chiefly consist of providing indications, recommendations (France) and consultancy services (UK) (see *Table 2).*

The Authorities' jurisdiction generally covers central departments and concerns information technology in France and Italy, and information technology and telecommunications in the other countries.

The Authorities are homogeneous, compact structures, with the exception of the CCTA, whose organisation is similar to that of a service company.

All the countries draw up long-term public administration computerisation programmes, which are used as a framework for the preparation and approval of annual budgets.

All the Authorities are responsible for defining common methodologies and recommending standards. The CCITT and CENELEC standards are the reference telecommunications standards.

Methodologies tend to be defined and recommended for software development and contracts; methodologies for strategic planning, vendor requirements and project monitoring are less widespread.

In the area of standards, the EU reference standards as regards operating systems (X.Open) and networking (OSI) are widely recommended; no clear recommendations have yet emerged as regards databases, languages and service quality.

Centralised procurements policies exist only in Spain and, to a decreasing extent, the United Kingdom.

4. The IT Market in Europe's Public Administrations

(for definitions, see the note on methodology at the end of the chapter)

4.1. The IT Market in the Public Administration Sector

In 1993, the EU public administration IT market was worth ECU 17,700 million, a rise of 0.6% from 1992.

The public sector's role as a driving force of the IT market has therefore slackened as a result of the recession and countries' indebtedness levels, which have made it necessary to curb public spending. This has slowed capital expenditure on major IT projects.

Actual spending and expenditure trends in the European countries analysed in this report are shown in *Table 3* and *Figure 1.*

	1992	1993	Δ 93/92
France	4,301	4,343	1.0
Germany	4,246	4,267	0.5
Italy	2,346	2,200	- 6.2
Spain	731	682	- 6.7
UK	3,319	3,426	3.2
Others	2,657	2,782	4.7
Total EU	**17,600**	**17,700**	**0.6**

Table 3
The IT Market in the PA Sector, 1992-93 (Million ECUs)

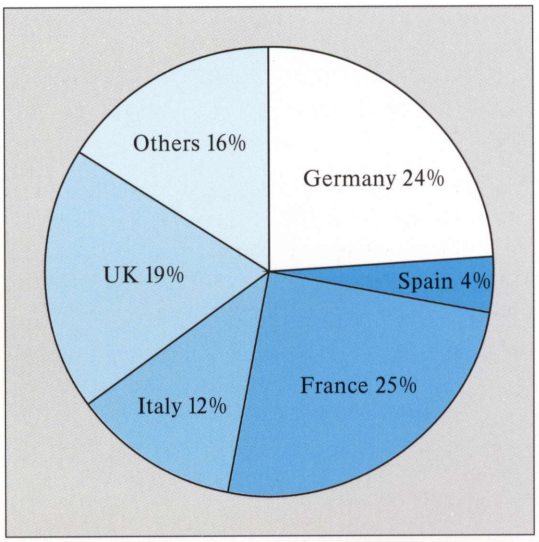


Figure 1
The IT Market in the PA Sector, 1993

In *France,* IT demand in the public administration in 1993 amounted to ECU 4,343 million, the highest level of the countries considered. Demand grew by 1% compared with 1992, in line with the European average.

The stability of IT demand in the French administration is largely related to the government's decision not to reduce current expenditure in order to guarantee employment levels; however, investments on new projects are tightly controlled.

In *Germany,* IT demand in the public administration in 1993 was ECU 4,267 million, the second highest level after France. Growth compared with 1992 was 0.5%, slightly below the European average.

The impact of the recession on the IT market was less marked in the public sector than in the private sector. For the time being, reunification with the east has stimulated moderate investments in hardware and software, particularly at local level, but is not expected to be a significant factor in market recovery before 1995.

In the *United Kingdom,* IT demand in the public administration in 1993 was ECU 3,426 million, and ranked third after France and Germany. Demand grew by an above-average 3.2% compared with 1992.

One of the main factors contributing to this trend is the UK public sector's widespread tendency to outsource overall management of services, including IT services. This is closely related to the government's privatisation policies.

In *Italy,* IT demand in the public administration in 1993 was ECU 2,200 million, a large decrease of - 6.2% compared with 1992. This was due chiefly to containment of IT expenditure in the public sector and to a period of adjustment as the administration adopts the recent procedural directives designed to improve planning and control of IT investments and projects.

In *Spain,* IT demand in the public administration was still very low, at ECU 682 million in 1993. As in Italy, demand fell by - 6.7% compared with 1992, mainly because of the economic crisis and the increase in the country's public debt, which led to the suspension of major projects launched during 1992.

IT market trends and values at central and local administrative levels also tend to differ.

Furthermore, demand at central and local levels also varies significantly from one country to another, depending mainly on the level of functional centralisation or decentralisation in the public administration (see *Table 4).*

Table 4
The Structure of Local Government

Countries		Levels of decentralization		
		1st Level (Body/ies and number)	2nd Level (Body/ies and number)	3rd Level (Body/ies and number)
France		26 Régions	100 Departements	36,547 Communes
Germany		16 Länder	452 Kreise	15,618 Städte und Gemeinden
Italy		20 Regioni	100 Provincie	8,078 Comuni
Spain		20 Comunitades Autonomas	43 Provincias	8,097 Municipios
UK	England & Wales	47 Counties	402 Districts	10,000 Parishes (E) 1,000 Communities (W)
	Scotland	12 Regions	53 Districts	
	Northern Ireland	29 Districts		

In 1993, central government and local government accounted for 61.7% and 38.3% respectively of the EU public administration IT market.

From 1992 to 1993, market growth was slightly faster at local level (1.4%), compared with 0.8% at central level *(Figure 2, Table 5)*.

In *France,* central administration accounts for a very large portion of the total market (80% in 1993), reflecting the high level of political/functional centralisation and significant IT spending in major Ministries (Finance, Defence, Health) and major authorities (Post Office, Pensions).

The faster growth of the IT market at central level (1.1%) is related to the extensive presence of long-term sectorial agreements, which tend to cushion overall market trends, and to the high level of current expenditure, which has not been subject to cuts. Growth was slower at local government level (0.4%), which is more exposed to budget reductions and more sensitive to hardware downpricing.

In the *United Kingdom,* too, central government accounts for the larger part of the IT market (70.2%). This is due to the presence of the three state levels and to the marked propensity of Ministries and central departments to outsource. Outsourcing is also one of the factors responsible for faster growth at central level (4%) compared with local level (1.4%) between 1992 and 1993.

A reverse situation exists in *Germany,* where, given the high political/functional decentralisation of the Länder, local government accounts for 54% of the IT market. The recession had a greater impact at federal government level, where the IT market decreased by - 1.1% between 1992 and 1993. The growth in the Länder market (1.9%) reflects both the maintenance of current expenditure levels and investments for twinnings with eastern Länder for basic technology transfers.

	Central Government			Local Government		
	1992	1993	Δ 93/92	1992	1993	Δ 93/92
France	3,447	3,486	1.1	854	857	0.4
Germany	1,981	1,959	- 1.1	2,265	2,308	1.9
Italy	1,224	1,116	- 8.8	1,122	1,084	- 3.4
Spain	405	363	- 10.4	326	319	- 2.1
UK	2,314	2,407	4.0	1,005	1,019	1.4
Others	1,526	1,582	3.7	1,131	1,200	6.1
Total EU	**10,897**	**10,913**	**0.2**	**6,703**	**6,787**	**1.2**

Table 5
The IT Market in Central and Local Government, 1992-93 (Million ECUs)

In *Italy,* central government accounted for 50,7% of the total IT market in the public administration sector and showed a stronger decline than local government (- 8.8% compared with - 3.4%). This reflects the cuts in large IT orders in the main Ministries.

In *Spain,* central government accounted for 53% of the total IT market in 1993 and showed a stronger decline than local government (- 10.4% compared with - 2.1%). This was chiefly due to budget cuts in the main Ministries (Employment, Economy and Finance, Health, Justice) and to the suspension of major projects.

At *EU level,* the main factors influencing IT market trends in the public administration sector between 1992 and 1993 were the decline in hardware demand (- 5.2%), which reflects overall market trends, and continued growth in software and services (4.7%), see also *Table 6.*

Opposing hardware and software trends emerged in France (- 4.2%; +4.3%), Germany (- 6.2%; +5.2%) and the United Kingdom

Figure 2
The PA Market in 1993, % Central and Local Government on the Total

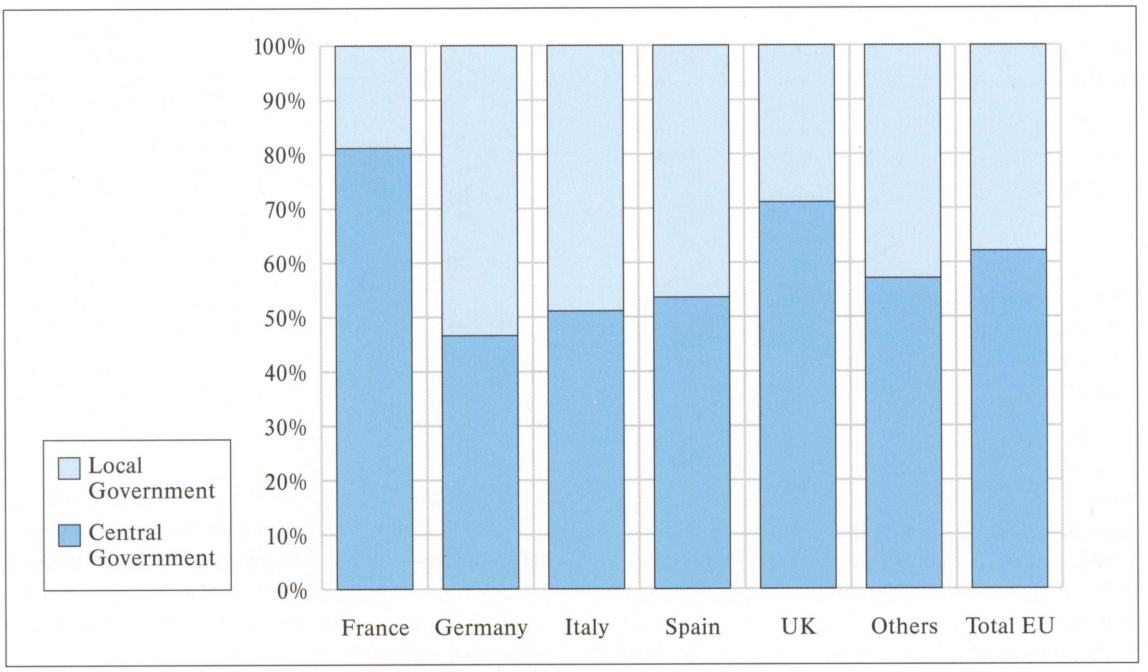


Table 6
The PA Market for Hardware and Software/Services, 1992-93 (Million ECUs)

	Hardware			Software/Services		
	1992	1993	Δ 93/92	1992	1993	Δ 93/92
France	1,699	1,627	- 4.2	2,603	2,716	4.3
Germany	1,752	1,643	- 6.2	2,495	2,624	5.2
Italy	856	746	-12.9	1,490	1,454	-2.4
Spain	365	318	-12.9	366	363	-0.8
UK	1,068	1,037	- 2.9	2,251	2,389	6.1
Others	1,093	1,052	- 3.8	1,562	1,731	10.8
Total EU	**6,833**	**6,423**	**- 5.2**	**10,767**	**11,277**	**4.7**

(- 2.9%; +6.1%). In Italy and Spain, a strong decline in hardware demand (- 12.9) was also accompanied by an albeit slower decline in the software and services market (- 2.4% in Italy; - 0.8% in Spain).

In general, the decline in the hardware market was related on one hand to downpricing and downsizing, which are specific to the IT sector, and on the other to the increased emphasis of public administration demand on applications and processes.

A breakdown of the IT market in the European public administration sector shows that software/services account for a larger share than hardware (in 1993, 63.7% compared with 36.3% respectively). Hardware's minor role can be observed in all the countries considered, although interesting differences emerge from one country to another (see *Figure 3).*

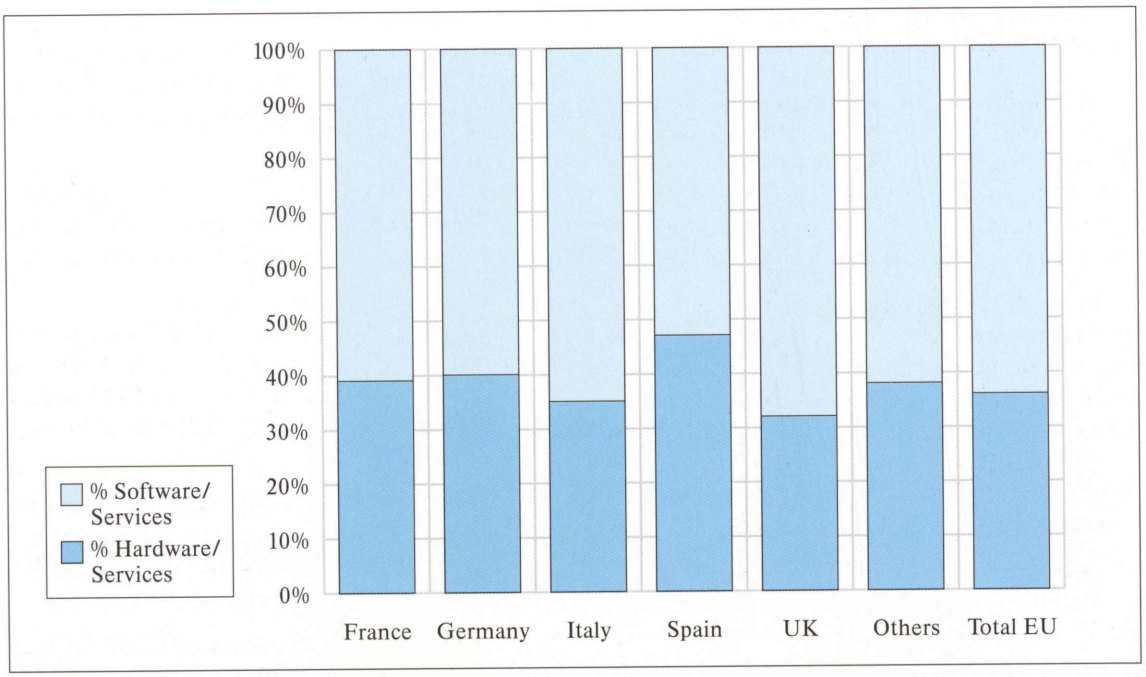


Figure 3
The PA IT Market in 1993, % Hardware and Software/Services

In *Spain,* where computerisation is still at the level of investment in basic equipment, the hardware component accounts for 46.7% of the market, a share higher than the European average.

Slightly higher-than-average percentages can be observed in *France* (37.5%) and *Germany* (38.5%), related to the continued existence of a large number of major EDP centres in government departments (e.g., in the French Ministry of Finance).

The *United Kingdom* has the smallest hardware component, which at 30.2% is below the European average. This is due both to the privatisation of large organisations which were previously part of the public administration, and above all to the use of outsourcing, which has reduced hardware spending in relation to spending on services.

Italy also has a lower-than-average hardware component (33.8%). This reflects the public administration's current focus on IT applications, following major hardware investments in previous years.

In general, the growing tendency of the public administrations to view IT as a tool to rationalise and improve the quality of services is shifting attention increasingly towards applications, fuelling demand for packages and for system integration and outsourcing services.

At the application level, although traditional centralised application architectures remain, a move towards distributed architectures can be seen, particularly for new or re-engineered applications. Although distributed application architectures are restricted today by rigid organisational and functional structures, the reorganisation processes now being put into place will provide a powerful stimulus for their wider use.

4.2. Comparative Indicators of the Diffusion and Role of IT

The diffusion of information technology in the public sector and the relative weight of the public administration IT market in relation to both the overall IT market and overall public-sector expenditure vary considerably among the European countries analysed here (see *Table 7).*

In particular, the public sector's share of the total IT market can be assumed as a comparative indicator of the relative importance of IT spending in the public sector compared with IT spending in other economic sectors; it also indicates the extent to which, in each country, the public administration acts as a locomotive for the national IT market (see *Figure 4).*

In 1993, the public administration's share of the national IT market was highest in France (22.4%), compared with an EU average of 17.4%.

The United Kingdom share was similarly high (18.2%), and above the European average.

Italy ranked third (15.7%); although this level is below the EU average, it has improved over the last few years thanks to significant growth in public sector IT spending between 1990 and 1992.

Lower percentages than the EU average were recorded in Germany (16%), where the private sector still predominates, and in Spain (14%), where public administration market values are still low.

Another indicator of the public sector's propensity to invest in IT is the relationship between the public administration IT market and national GDP.

Against an EU average of 0.32%, values were higher in France (0.46%) and the UK (0.43%), in line with the average in Germany (0.35%) and lower than average in Italy (0.25%) and, in particular, in Spain (0.17%).

The share of the public administration IT expenditure in relation to total public administration expenditure indicates the comparative importance of IT in the public sector.

Against an EU average of 0.60%, the UK had the highest ratio (1.0%); this reflects curbs on overall public spending and the tendency to outsource IT services. The share in France (0.80%) was also above the EU average, while Germany (0.60%) was in line with the EU average, reflecting the high level of public spending for personnel and basic infrastructures.

Table 7
Comparative Table of 1993 IT Diffusion and Role of IT

Indicators	France	Germany	Italy	Spain	UK	Total EU
IT P.A. expenditure/Total IT expenditure (%)	22.40	16.00	15.70	14.00	18.20	17.40
IT P.A. expenditure/Total PA expenditure (%)	0.80	0.60	0.40	0.30	1.00	0.60
IT P.A. expenditure/GDP (%)	0.46	0.35	0.25	0.17	0.43	0.32
IT P.A. expenditure/P.A. employees (thousand ECU)	1.09	0.98	0.63	0.37	0.84	0.83
IT P.A. expenditure/Population (ECU)	75.90	53.10	38.10	17.50	59.40	51.10
IT P.A. employees/Total PA employees (%)	8.20	7.10	5.10	4.10	9.80	7.40

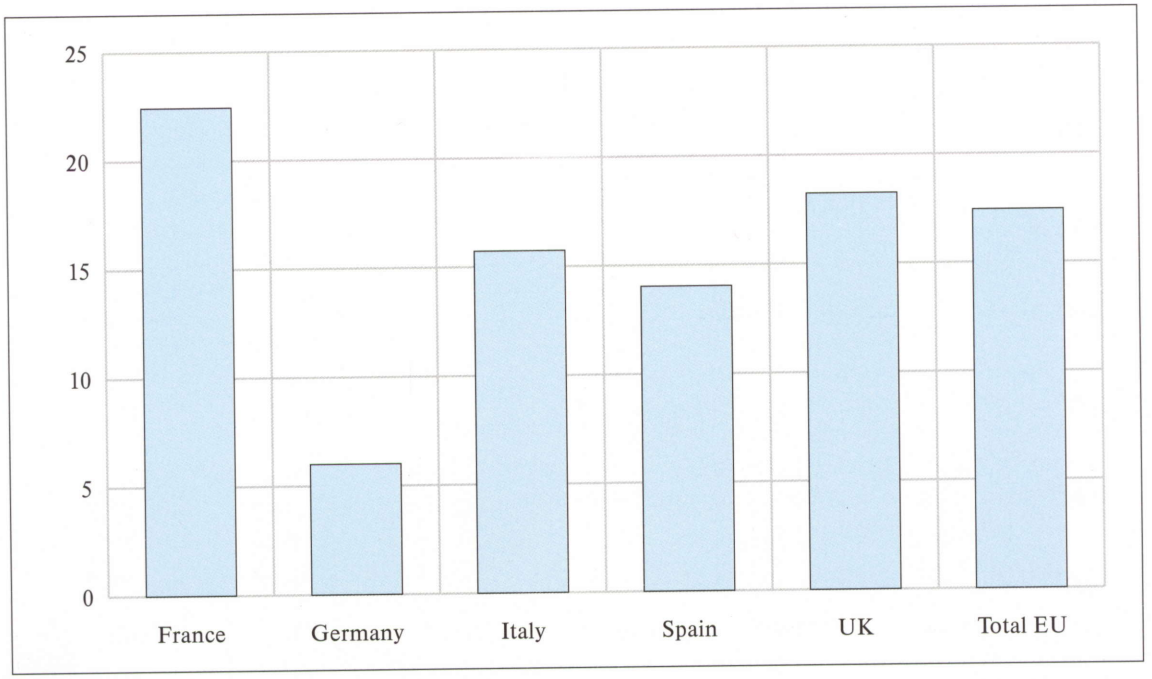


Figure 4
PA IT Expenditure/ Total IT Expenditure, 1993

Italy (0.40%) and Spain (0.30%), where IT market values are still low, were below the EU average.

The ratio between the public administration IT market and public-sector employees is another indicator of the diffusion of IT in the public administration. The EU average is ECU 830 per employee *(Figure 5)*.

Of the countries analysed here, France has the highest ratio (ECU 1,090), which arises chiefly from the volume of the public administration IT market.

The similarly high ratio in the UK (ECU 840) probably reflects employment cuts stemming from privatisation.

The indicator in Germany (ECU 980) reflects the impact of reunification, which has led to a significant increase in public-sector employment levels.

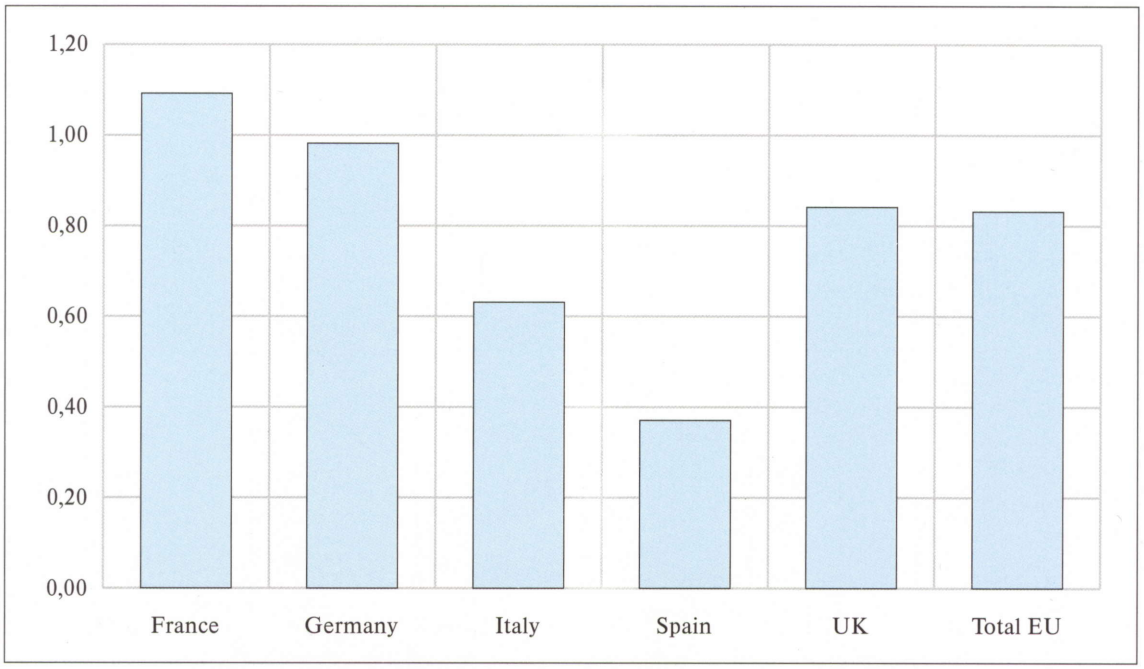
The ratio in Italy (ECU 630) is below the EU average.

The ratio in Spain (ECU 370) is also lower than the EU average, due chiefly to the fact that public administration computerisation is still at a preliminary stage.

An additional indicator of the level of IT diffusion, average IT spending in the public administration per inhabitant, confirms the differences described above.

Clearly, the indicators analysed here are closely related to the structural differences between the countries caused by varying levels of computerisation in the public administration.

Figure 5
PA IT Expenditure/
PA Employees, 1993
(Thousands of ECU)



It should also be observed that the existence of a direct connection between public administration IT spending and the level of quality of processes and services has not been established. Quality is closely linked to the public administration's ability to rationalise and optimise organisational/functional processes and to use IT as a support tool. A new approach to information technology, which views investment planning and control as a key factor in guaranteeing consistency between IT investments and the administration's strategic objectives, is therefore increasingly important.

4.3. IT Resources and Human Resources in Public Administration

In 1993, installations in central and local government departments in the countries considered consisted of a total of 2,860 mainframes, 60,300 minicomputers and large numbers of personal computers and terminals (see *Table 8).*

All the countries considered have large mainframe installations at central government level, especially in France (600) and Germany (568).

Local government has fewer mainframes, except in Germany (455 local government mainframes) with its decentralised Länder.

Mainframe installations are decreasing however as a result of the move towards fewer "glass houses" and CPUs, a trend that is already emerging in other economic sectors. In addition, new applications and re-engineered applications now tend to be run on distributed platforms.

Minicomputer installations are widespread in all the countries, both as a platform for the peripheral sites or departments of central government and, above all, as a platform for medium and medium/large local government offices.

Nevertheless, minicomputer installations are stable.

Countries	Mainframe		Mini		PC		Terminal	
	Central Govern.	Local Govern.	Central Govern.	Local Govern.	Central Govern.	Local Govern.	Central Govern.	Local Govern.
France	600	140	6,000	10,000	155,000	120,000	90,000	30,000
Germany	568	455	4,000	8,500	70,000	150,000	75,000	82,000
Italy	310	110	9,500	9,500	70,000	105,000	75,000	25,000
Spain	200	60	1,700	2,700	23,000	35,000	16,000	17,000
UK	215	205	3,400	5,000	60,000	160,000	65,000	100,000

Table 8
Hardware Installations in 1993 (Units)

Personal computers are widely used in all the countries, particularly at local government level, both in network configurations and as stand-alone equipment, and also at central level, as workstations.

Installations have slowed notably, especially when compared with trends in the late 1980s.

In all the countries analysed, the authorities that coordinate and guide public administration computerisation recommend the use of standards such as X.Open for operating systems and OSI for networking. Generally speaking, these recommendations are followed, especially in new developments and new purchases.

The number of EDP employees in the public sector varies considerably from one country to another (see *Table 9).*

The highest number of EDP employees is in Germany (60,000), where reunification has significantly raised employment figures. France's public administration also has a large number of EDP employees (53,000). The UK figure is lower than the other countries except Spain, as a result of privatisation and outsourcing, which have led public sector employees to move to the private sector and to outsourcing suppliers.

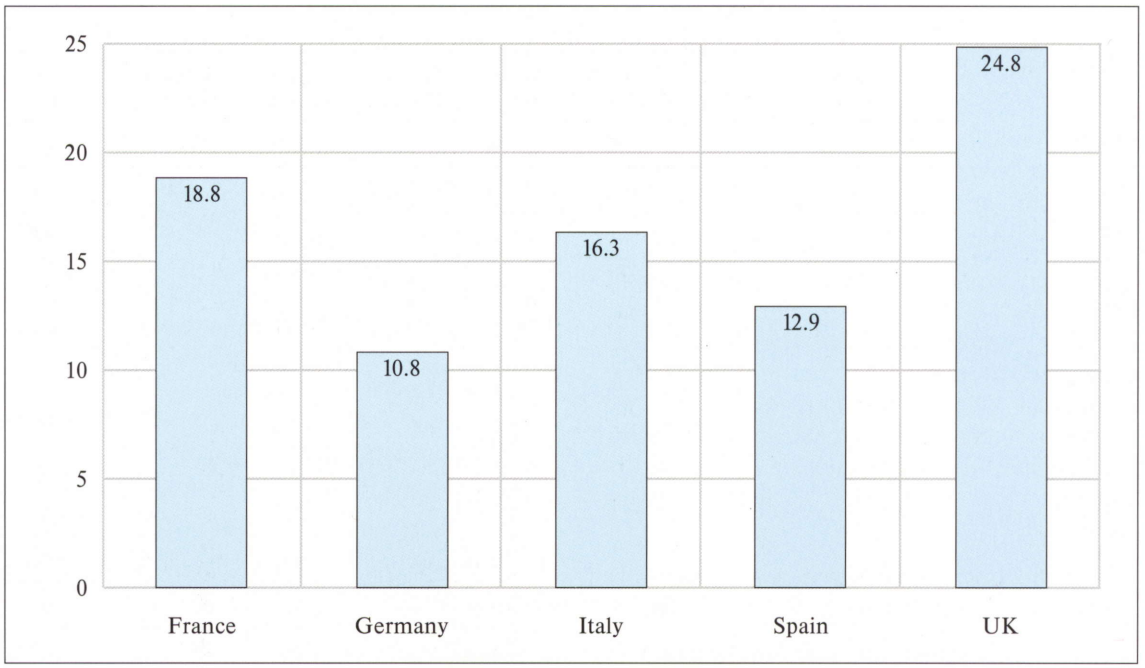
Countries	Central Government (Unit)	Local Government (Unit)	Total (Unit)
France	41,000	12,000	53,000
Germany	27,000	33,000	60,000
Italy	23,000	17,000	40,000
Spain	7,500	9,000	16,500
UK	20,000	15,000	35,000
Total EU	**140,000**	**100,000**	**240,000**

* EDP employees: system engineers, analysts, programmers, service engineers, terminal operators

Table 9
EDP Employees in Central and Local Government, 1993*

The number of workstations (see *Figure 6)* per public administration employee, which can be taken as a partial indicator of the level of computerisation in the public sector, is high in the United Kingdom (24.8 workstations per 100 employees), followed by France (18.8) and Italy (16.3). Spain (12.9) and Germany (10.8) are further behind. The German figure is a further indication of the impact of reunification, which has brought a huge increase in employment in the public sector.

Figure 6
Number of Workstations (PCs and Terminals) per 100 Employees



4.4. Application Areas Covered by Major Projects

In line with overall trends in Europe and emerging trends in the USA, a new phase can be observed in the countries considered here, in which one of the priorities for overall national economic recovery is to improve the efficiency of public administration and the quality of public services.

The public administrations of the countries considered here are drawing up plans and programmes focusing on: re-engineering of administrative procedures and processes; integration of processes among and within administrations; improvement of the quality of services provided for individual citizens and the corporate sector.

These objectives are the main areas on which the European public administrations are or will be focusing their IT investments. In the medium term, this trend will provide a powerful stimulus for new IT and telematics demand, and could revitalise the market as a whole.

The *United Kingdom* is concentrating on improvements in the services provided for the citizen/customer, after a period dedicated to the reduction of costs. This trend is closely linked with the privatisation of public services and the creation of Next Step Agencies, which operate as profit and loss centres. Outsourcing is the area offering the greatest opportunities in the UK today as action is taken to reduce the number of internal EDP centres.

In *Germany,* integration of the eastern Länder is the main focus of government action. At the present time, the goal of the main public investment programmes is to create basic infrastructures rather than IT infrastructures.

Major IT and telematics investments designed to integrate and improve the efficiency of the public administration are planned for the second half of the 1990s. The most important project planned in this area is the distribution of federal government offices between Bonn and Berlin, with the creation of a major communications network.

Current projects focus on computerisation in basic areas in order to integrate the east, for example, pensions and tax and post codes. Twinning projects between western and eastern Länder are also being set up to promote IT transfers and support computerisation of basic applications.

The need to retrain public-sector employees in the east could fuel significant demand for training and consultancy services.

In *France,* IT projects and investments aim in particular to improve public services by integrating administrative departments and modernising procedures. In this area, France has a well-established tradition of IT and communication infrastructures (minitel, smart cards), which are widely used by both private individuals and the corporate sector. Current projects focus in particular on the integration of new services in the areas of health and national insurance.

Other investment areas include the re-engineering of ministerial administrative and management procedures and the development of networks and architectures for interministerial communications. Projects are underway or planned in the Ministries of Finance, Defence, Education, Internal Affairs, Health and Pensions.

In *Italy,* attention focuses on the re-engineering and improvement of processes and services, supported by new procedural directives.

The main priorities for public administration IT investments and projects are: transparency in administrative processes, service quality, cost rationalisation, and inter-departmental integration.

Priority areas are health, pensions, taxation, with special emphasis on services for the citizen (e.g., self-service, information points).

In *Spain,* the moratorium on major projects has created a temporary standstill. Nevertheless, at local government level, greater attention is being paid to areas such as self-service for citizens, GIS systems, optical storage systems. At central level, major projects focus on integrated database management, interministerial electronic mail systems, public information systems.

Over the medium/long term, public administration investments will necessarily address the following main areas, although countries' approaches and timetables will differ, both in Europe and worldwide:

- administrative re-engineering through rationalisation, simplification and integration of administrative and accounting procedures;
- better services for citizens and the corporate sector: introduction of new services, self-service systems, remote access to administrative procedures and information, remote payments;
- communications infrastructures to support integration among administrative departments, between the administration and the corporate sector, between the administration and the citizen, and to support administrative decentralisation;
- personnel retraining.

4.5. A New Approach to IT in Public Administration and Outsourcing

The need to improve public services and redefine procedures involves a re-engineering of IT systems. In this new phase, a tendency to outsource IT services can be observed in some of the countries considered here.

In the *United Kingdom,* the use of external information systems and the move towards outsourcing solutions for management of the administration's services as a whole is already underway. The trend is closely related to privatisation and the reduction in the number of EDP centres. The main reasons for the decision to outsource in the UK are the level of cost reductions expected and the greater efficiency achieved.

In *Germany,* the public administration is beginning to move towards outsourcing solutions, which it regards as an opportunity to access greater skills and raise efficiency.

In *Spain,* while central government departments resist the idea of outsourcing, overall management of the services provided at local level is being assigned to external suppliers, with a view to reducing costs.

Although *Italy* has a tradition for outsourcing IT system management in its main government departments, the choice between insourcing and outsourcing is still open; the final decision will depend on the introduction of IT planning and control methodologies which guarantee conservation of systems within strategic areas.

France tends to prefer insourcing solutions, to guarantee employment and process control.

4.6 Public Administration IT Market Trends: 1994-1995

A moderate upswing is forecast for the public administration market in 1994 and 1995 within the EU as a whole (1.7% from 1993-94; 3.3% from 1994-95), see *Table 10* and *Figure 7.*

Table 10
The IT Market in the PA Sector, 1994-95 (Million ECUs)

Countries	1994	Δ 94/93	1995	Δ 95/94
France	4,428	2.0	4,556	2.9
Germany	4,349	1.9	4,551	4.6
Italy	2,213	0.6	2,314	4.6
Spain	656	-3.8	666	1.5
UK	3,497	2.1	3,557	1.7
Others	2,857	2.7	2,956	3.5
Total EU	**18,000**	**1.7**	**18,600**	**3.3**

Improvements are expected in each country considered here, except the *United Kingdom,* where a slight slowdown is expected, mainly as a result of a decrease in hardware and software investments related to the growing use of outsourcing.

In *Italy,* a recovery is forecast in the public administration IT market (0.6% from 1993-94; 4.6% from 1994-95) related to low-level computerisation in certain areas and the start-up of programmes to improve processes and services.

A market recovery is also expected in Spain, although the trend will be slower, with a further decline between 1993 and 1994 (-3.8%) and growth between 1994 and 1995 (1.5%). This slow recovery will be driven by the need to standardise and raise computerisation levels, by improvements in services for private individuals and by the outsourcing of services in the main local government departments.

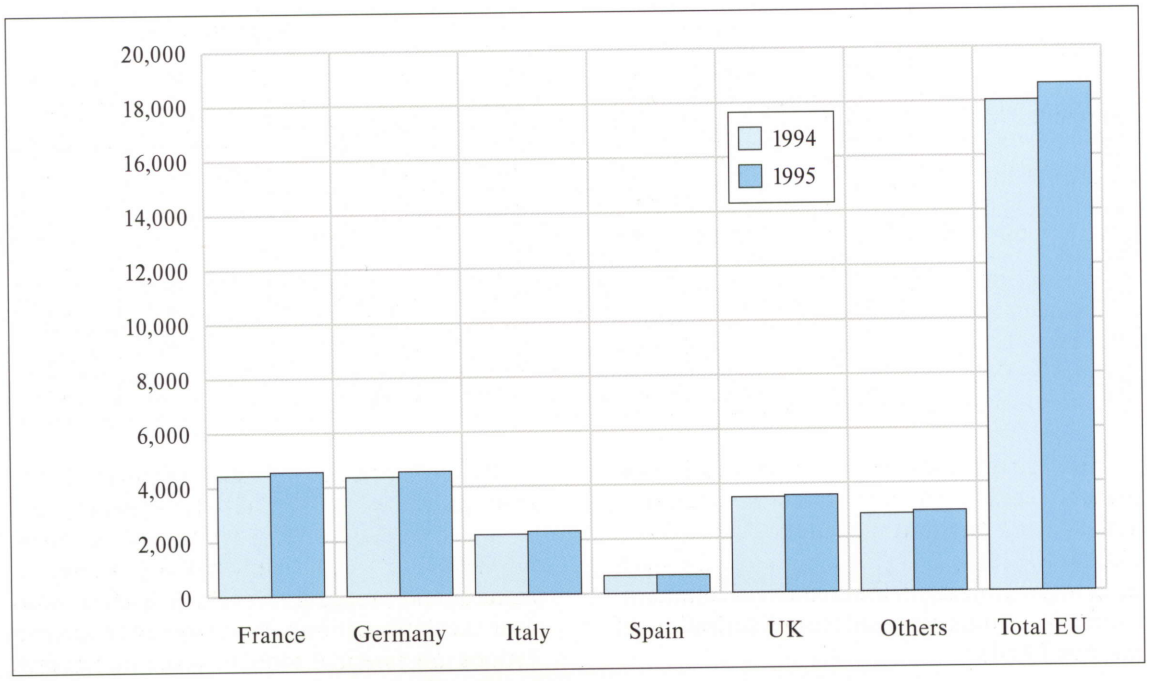


Figure 7
The IT Market in the PA Sector, 1994-1995

Countries	Central Government				Local Government			
	1994	Δ 94/93	1995	Δ 95/94	1994	Δ 94/93	1995	Δ 95/94
France	3,559	2.1	3,664	3.0	869	1.4	892	2.6
Germany	1,964	0.3	2,035	3.6	2,385	3.3	2,516	5.5
Italy	1,093	-2.1	1,149	5.1	1,120	3.3	1,165	4.0
Spain	338	-6.9	338	0.0	318	-0.3	328	3.1
UK	2,451	1.8	2,492	1.7	1,046	2.6	1,065	1.8
Others	1,617	2.2	1,664	2.9	1,240	3.3	1,292	4.2
Total EU	**11,022**	**1.0**	**11,342**	**2.9**	**6,978**	**2.8**	**7,258**	**4.0**

Table 11
The IT Market in Central and Local Government, 1994-95

Table 12
The Hardware and Software/Services Market in the PA Sector, 1994-95 (Million ECUs)

Countries	Hardware				Software/Services			
	1994	Δ 94/93	1995	Δ 95/94	1994	Δ 94/93	1995	Δ 95/94
France	1,586	-2.5	1,568	-1.1	2,842	4.6	2,988	5.1
Germany	1,558	-5.2	1,536	-1.4	2,791	6.4	3,015	8.0
Italy	703	-5.8	723	2.8	1,511	3.9	1,591	5.3
Spain	290	-8.8	281	-3.1	365	0.6	385	5.5
UK	1,013	-2.3	975	-3.8	2,484	4.0	2,582	3.9
Others	1,016	-3.4	1,009	-0.7	1,841	6.4	1,947	5.8
Total EU	**6,166**	**-3.4**	**6,092**	**-1.2**	**11,834**	**4.9**	**12,508**	**5.7**

The improvement in market trends in *Germany* is expected to be moderate between 1993 and 1994 (1.9%), and stronger from 1994-95 (4.6%). The recovery will be related to the start-up of major projects for the creation of communication infrastructures and computerisation of the new Länder.

Analysis of the trends forecast for the public administration IT market at central and local government levels respectively indicates that, both within the EU as a whole and in the individual countries, growth will generally be faster at local level, except in France, see also *Table 11.*

As can be seen from the breakdown of the public administration IT market into hardware and software/services, the launch of new programmes and IT projects designed to boost efficiency and improve quality will stimulate a partial recovery in hardware demand, although this will continue to decrease overall, both within the EU as a whole and in the individual countries. Positive trends and growth are forecast in software/services *(Table 12).*

A significant recovery in the public sector IT market will probably not emerge until the second half of the 1990s, as a result of the re-engineering processes and service improvements now being studied in the various countries.

It should be noted that the implementation of these processes, which will lead to sweeping strategic and functional change in the public sector, primarily involves measures at organisational, cultural and procedural levels. It is clear, however, that information technology and communications are essential tools to make this change possible. In the second half of the 1990s, therefore, the public sector is likely to be a testbed for the introduction of information technology to support changes of significant social importance, and an important stimulus for the IT market as a whole.

4.7. Methodology

The data in chapter 4 refer to the public administration IT markets in France, Germany, United Kingdom, Italy and Spain.

The European aggregate refers to the EU countries.

Market data refer to the end-user market for IT goods and services, where end-user market signifies the value of goods and services acquired annually by the end-user, directly from vendors or through indirect distribution channels.

The IT market considered here does not include:

- telecommunications;
- office equipment;
- expenditures for internal personnel.

The public administration comprises:

- Central government departments:
  Ministries and their peripheral sites;
  Central Bodies and their peripheral sites (Post, Social Security);
  Armed Forces and Military Corps;
- Local government departments:
- Local Bodies;
- Health Unit;
- Education (Schools and Universities).

The public administration does not include:

- utilities (electricity, gas, water);
- transport (railways etc), telecommunications;
- radio and television.

Local Government in the countries include:

France	Régions, Départements, Municipalities
Germany	Länder, "Kreise" (Districts), "Städte und Gemeinden" (Municipalities)
Italy	Regions, Provinces, Municipalities (Comuni)
Spain	Regions (Comunidades autonomas), Provinces, Municipalities (Municipios)
UK	Counties, Districts, Parishes and Communities (for England and Wales) Regions, Districts (for Scotland) Districts (for Northern Ireland)

Part Three

Statistical Outlook

The data and forecasts presented in this section have been jointly prepared by International Data Corporation IDC and the EITO Task Force on the basis of the information available at the end of November 1993.

1. Introduction

This section presents statistics which illustrate the shape and structures behind the IT and communications markets in Europe. The subject is presented in three main sub-sections. The first is concerned with the shape of the various national IT markets, within an international context, and the patterns of trade between them. The second section examines the individual market structures with an eye on the competitive aspects, as well as comparative measures of IT penetration. In the third section, the focus switches to the role of technological advancement in altering the underlying economics of IT. Terms are defined at the end of the section.

A number of changes have been made in this, the second, statistical section of the European Information Technology Observatory since the first edition. The most significant change has been the incorporation of detailed statistics concerning telecommunications markets. For the first time, detailed figures are given for both the telecommunications markets and associated trade flows for each of the countries covered in continental Europe.

In addition, the geographical scope of all the trade data reported has been expanded to include the US, Japan and major EFTA countries. This allows for an enhanced understanding of the relative position of the major IT producing regions in the World.

2. Methodology

Government statistical bodies tend to model the world starting with the system of national accounts. Agreed classifications for industrial activity and trade thus become the measures against which markets are assessed. In many areas the restrictions imposed by such classifications and by the rigorous methods used to collect and process information are too great to make the resulting information useful to the business community. The IT market is a case in point, and the failure of the standard classifications to get to grips with the subject of software is a specific limitation.

This study is an attempt to shed light on some of the more important aspects of the European markets for telecommunications and information technology products (and services), including substantial elements of the associated market for office automation products.

The basis for the study is the marketplace. Thus, instead of defining the marketplace in terms of what is produced plus the balance of trade, IDC's research is aimed at measuring the market. Valuation is largely based upon the revenues paid to primary vendors, with research results cross-checked against a continuous programme of end-user interviews and distribution channel monitoring. Data on trade flows have also been collected, and matched as closely as possible to IDC's market oriented segmentation, since these data can tell us things about the position of Europe with respect to the World. What is presented then, is a comprehensive body of data which aims to illuminate the European IT Market, to cast light onto the situation of the markets' major players and the underlying competitive structures.

Given the extraordinary scope of this study in terms of subject matter and data sources a degree of compromise is necessary in designing an appropriate methodology. The same principles apply to IDC's standard research into the IT industry. Because markets differ widely in structure and nature, and because consumers of market research attach different values to various levels of data, a variety of methods are used to research different aspects of the IT landscape.

Thus, IDC's overall methodology should be viewed not as a single simple entity, but rather as a complex product of an optimisation process which reflects the value placed upon information by its consumers. To illustrate the composite nature of the methodology consider the contrasting markets for mainframe computers and PCs. Mainframes are generally sold by a direct sales force to the end user organisation without the intervention of channel intermediaries. As a result, IDC is able to research this marketplace by monitoring the revenues accruing to primary suppliers of mainframes. In the PC market, the heavy reliance on channel intermediaries means that to focus purely on primary suppliers' revenues understates the market size. As a result, IDC measures the PC market by reference to street prices rather than factory revenues. Similarly, the activities of value-added-resellers are monitored via IDC's software and services and distribution channels programmes, allowing for a complete picture of the market.

3. European ICT Markets and Patterns of Trade

For the purpose of this study, with an emphasis on the industry supplying goods and services in return for payment, we deal largely with the value of revenues paid to primary vendors for information technology goods and services. For an expanded discussion of the principles implicit within this study readers are referred to the section on definitions, which appears later in this volume.

All forecast data are prepared in local currencies and subsequently converted into constant 1992 ECU using the exchange rates listed at the end of the definitions section. Growth rates therefore correspond to local currency growth rates. No adjustment is made for the effects of inflation. Trade data are reported in current ECUs, according to the standard reporting conventions.

In terms of classes of product, again a full account appears later in this volume. Here we note that the definition of the hardware marketplace has been expanded beyond the traditional IT systems arena, to include a broad category of office hardware technologies such as photocopiers, typewriters and calculating machines, and tele- and datacommunications equipment and services.

In terms of geography, the presentation used here is based firmly upon market realities. As the rate of growth in information technology markets has reduced substantially, vendors have been encouraged to pursue opportunities in markets remote from their traditional operations. This is reflected in increased interest in the smaller EU markets, such as Greece, Ireland and Portugal, and further afield in Eastern Europe. As research continues into these markets and as the markets themselves develop, the level of detail at which information is meaningful will change. Until then, the basis of segmentation for some of these countries falls short of that used in the established markets. The major areas in which detailed data is lacking for such countries is in the fields of information technology services and telecommunications products and services. This is reflected in the presentation which follows.

Throughout the statistical section Eastern Europe is considered to refer to the former Czechoslovakia, Hungary, Poland and the former Soviet Union. Bulgaria and Romania are not covered by the analysis. The EFTA is represented by data on Austria, Finland, Norway, Sweden and Switzerland (Liechtenstein and Iceland are not included). The heading EU refers to Belgium and Luxembourg, Denmark, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Spain, Portugal, and the UK.

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6. Economic Background

In December 1993, the OECD noted that the current low levels of growth evident amongst the member states of the OECD was not a novelty, but had been a feature of the past three years. One conclusion reached at that time was that a solid recovery was still some way off.

Of course the experience of individual nations varies, particularly in terms of economic fortunes. In the US a steady recovery appears to have taken hold. But in Japan there are still question marks over the ability to recover lost momentum quickly, and in Europe there are still serious concerns about the timing and strength of recovery.

Overall for the OECD, a gradual recovery in economic activity is expected to commence in 1994, with the rate and extent of recovery contingent on the speed with which monetary conditions are eased in continental Europe, and the effects of combined monetary and fiscal stimuli in Japan.

Figures 1, 2 and *3* chart the progress of growth in real gross domestic product, nominal gross domestic product and gross private non-residential fixed capital formation (GPCF) for the period from 1980 to date, and with estimates and forecasts for 1993, 1994 and 1995 respectively. The timing and extent of recession in the US, Japan and OECD Europe are clearly visible.

The principal features of the current European economic environment are:

- a crisis in economic growth;
- high (but falling) European interest rates;
- weak business and consumer confidence;
- contracting private sector investment.

At the heart of the problem lies the German economy. With the Deutschmark still acting as the de facto anchor of the remains of the exchange-rate mechanism (ERM) German economic policies designed to address national conditions have international impact. In particular, German attempts to combat sustained inflationary pressures at home have resulted in the requirement to maintain interest rates elsewhere at higher levels than domestic conditions alone require.

One notable feature of the current European economic landscape is the counter-cyclical recovery underway in the UK. Although modest in extent, the performance of the UK economy is clearly at odds with the greater European experience.

The issue of the current and recent level of European interest rates has been singled out for comment by the OECD. They contend that during the 1980s and on into the early 1990s, real interest rates are high when compared to the rates in operation for the two previous decades.

Although there has been some downwards movement in short term interest rates in Europe recently, it is argued that the real level of interest rates is still too high. The depressed state of the European economy is quoted as evidence in support of this contention.

The current dilemma facing the Europeans is summarised by the German position. Domestic considerations, meaning inflation running at levels considered to be well above set policy objectives, suggests that the Bundesbank is unlikely to ease interest rates, in spite of the damage this may cause to growth prospects. External conditions, however, are operating in the opposite direction. Considerable political pressure is being exerted on the Germans to reduce their interest rates, to enable others to do the same.

Observed from a different direction, the problems of the European economy do not disappear. The results of monthly EC business surveys for the industrial, construction, and retail sectors, and of consumer confidence, show a gradual deterioration in confidence from 1989 onwards in each case.

Private sector investment, excluding the contribution from investment in homes, has varied considerably over the past decade according to the OECD. The recent behaviour of this measure is clearly in keeping with the other evidence on the European economy. *Figure 4* shows the development of gross private non-residential fixed capital formation for the US, Japan and OECD Europe from 1980 to 1995. Whilst it is evident that investment in the US has started to recover, the slump in investment Japan and Europe is distinct, and recovery is only forecast for 1994; it has yet to manifest itself convincingly.

The ICT market in an economic context

Whereas previous recessions have provided a boost to the ICT market, this is not the case today. The recession in Europe's economies has exposed and aggravated structural problems within the ICT market.

The depth and breadth of the recession is one factor. A second factor can be explained in terms of the simple passage of time. The ICT market today is at a rather different stage of its development, and so too are the customers who make up that market. The law of diminishing returns has placed limits on the ability of companies to combat recessionary pressures through investment in IT.

The third factor is the change that has occurred in the economics of competition. A new set of rules currently governs the relationships between the suppliers and consumers of ICT, and between different groups of ICT suppliers. As a result, the effects of recessionary pressures upon suppliers have been amplified, causing trauma and confusion. A significant contribution to the present problems facing many vendors can be traced back to the realities of competition in an increasingly open industry. Even as economic recovery takes root, the prospect of increasing deregulation of telecommunications markets over the next decade suggests that the pace of change is unlikely to abate.

Real GDP growth in %	1989	1990	1991	1992	1993	1994	1995
Austria	3.8	4.6	3.0	1.5	-0.5	1.0	2.3
Belgium	3.9	3.3	2.1	0.8	-1.2	0.9	2.0
Denmark	0.6	2.0	1.2	1.0	0.2	2.5	2.8
Finland	5.4	0.0	-7.0	-4.0	-2.0	-0.3	2.4
France	4.3	2.5	0.7	1.4	-0.9	1.1	2.7
Germany	3.6	5.7	4.5	2.1	-1.5	0.8	2.2
Greece	3.5	-1.1	3.3	0.9	0.5	0.9	2.1
Ireland	6.5	9.1	2.6	4.9	2.7	3.1	3.2
Italy	2.9	2.1	1.3	0.9	-0.1	1.7	2.3
Luxembourg	6.7	3.2	3.1	1.8	1.0	1.5	2.3
Netherlands	4.7	4.1	2.1	1.4	-0.2	0.6	2.2
Norway	0.6	1.7	1.6	3.3	1.6	3.2	3.8
Portugal	5.2	4.4	2.1	1.6	-0.4	2.0	3.1
Spain	4.7	3.6	2.2	0.8	-1.0	0.8	2.6
Sweden	2.4	1.4	-1.7	-1.7	-2.7	1.5	2.2
Switzerland	3.9	2.3	0.0	-0.1	-0.8	0.8	2.0
United Kingdom	2.1	0.5	-2.2	-0.6	2.0	2.9	2.9
USA	2.5	1.2	-0.7	2.6	2.8	3.1	2.7
Japan	4.7	4.8	4.0	1.3	-0.5	0.5	2.3

Source: OECD, December 1993

Table 1
Real GDP Growth, 1989-1995

Nominal GDP growth in %	1989	1990	1991	1992	1993	1994	1995
Austria	6.7	7.6	6.5	6.0	3.2	3.9	5.0
Belgium	8.6	6.0	4.7	4.7	1.7	3.1	4.0
Denmark	4.8	4.7	3.8	3.0	1.8	5.3	5.4
Finland	11.7	5.3	-4.9	-3.0	-1.8	1.1	4.8
France	7.4	5.6	3.7	3.7	1.4	3.0	4.3
Germany	6.1	9.0	8.7	7.5	2.4	3.8	4.3
Greece	16.5	19.6	21.4	16.0	13.8	12.2	11.2
Ireland	11.3	7.3	3.6	6.1	5.5	6.5	6.6
Italy	9.3	9.9	8.7	5.7	3.7	5.8	5.3
Luxembourg	13.1	6.2	6.1	6.4	4.5	4.3	5.1
Netherlands	6.0	6.5	5.0	3.9	1.7	2.7	4.3
Norway	6.5	6.3	4.0	2.2	3.9	4.5	6.2
Portugal	18.8	19.3	16.5	15.9	5.4	6.9	7.5
Spain	12.2	11.3	9.4	7.4	3.4	4.4	5.6
Sweden	10.6	10.3	5.8	-0.1	-0.5	3.5	4.8
Switzerland	8.2	8.2	5.4	2.5	1.4	2.5	3.8
United Kingdom	9.3	6.8	4.2	3.8	4.0	6.0	6.0
USA	7.1	5.6	3.2	5.5	5.5	5.6	5.5
Japan	6.7	7.2	6.2	3.2	0.5	1.2	3.0

Source: OECD, December 1993

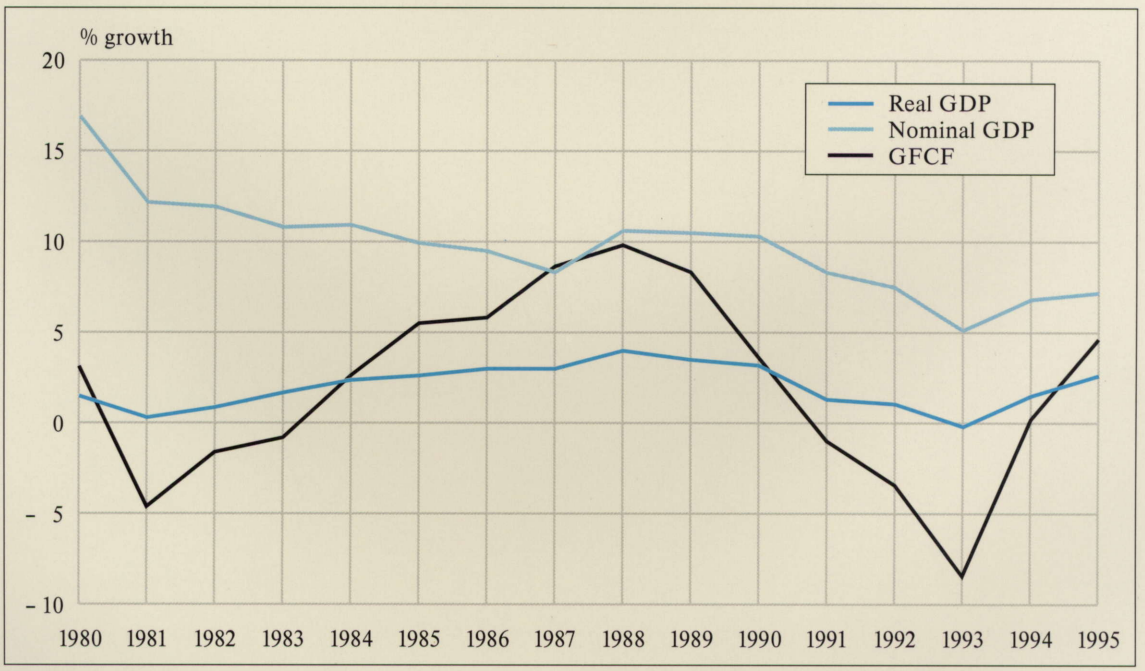
Table 2
Nominal GDP Growth, 1989-1995

Table 3
Gross Private Non-residential Fixed Capital Formation, 1989-1995

	1989	1990	1991	1992	1993	1994	1995
Gross private non-residential fixed capital formation (growth) in %							
Austria	8.6	8.7	5.1	- 1.6	- 4.6	0.1	3.0
Belgium	15.3	8.7	- 0.4	- 3.5	- 7.5	0.5	2.0
Denmark	5.8	3.9	- 2.7	- 13.4	- 2.5	5.0	7.0
Finland	15.5	- 6.4	- 24.6	- 21.0	- 15.0	- 5.0	5.0
France	8.6	4.4	- 1.8	- 4.2	- 8.5	- 1.0	4.5
Germany	7.6	10.3	8.2	- 0.9	- 7.7	1.5	1.5
Greece	13.7	11.3	- 5.9	2.7	1.7	- 1.5	4.9
Ireland	14.7	14.9	- 11.5	- 4.9	- 0.4	3.1	3.3
Italy	4.7	2.3	- 2.9	- 3.3	- 12.9	2.5	6.9
Luxembourg	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Netherlands	7.8	2.4	4.4	- 0.8	- 4.8	- 1.8	3.0
Norway	- 1.6	- 32.7	5.7	7.3	8.0	- 0.3	5.1
Portugal	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spain	13.9	3.3	3.0	- 2.0	- 11.1	3.0	5.0
Sweden	14.4	- 0.9	- 15.5	- 16.4	- 10.0	3.0	6.0
Switzerland	5.2	3.3	- 3.6	- 8.5	- 7.3	- 2.7	3.0
United Kingdom	8.2	- 2.8	- 9.0	- 2.7	- 1.1	2.9	4.8
USA	1.7	1.2	- 5.9	2.9	10.8	9.9	85.0
Japan	16.6	11.4	5.7	- 4.0	- 8.5	- 3.8	2.7

Source: OECD, December 1993

Figure 1
Economic Growth in OECD Europe, 1980-1995



Source: OECD, December 1993

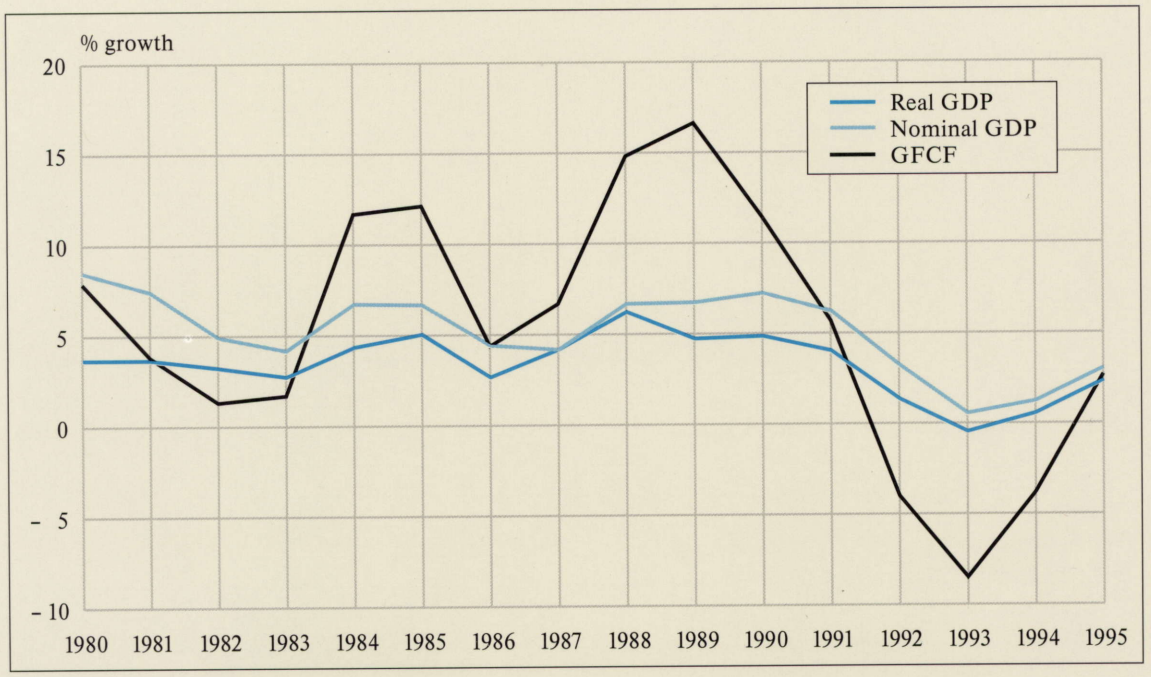


Figure 2
Economic Growth in Japan, 1980-1995

Source: OECD, December 1993

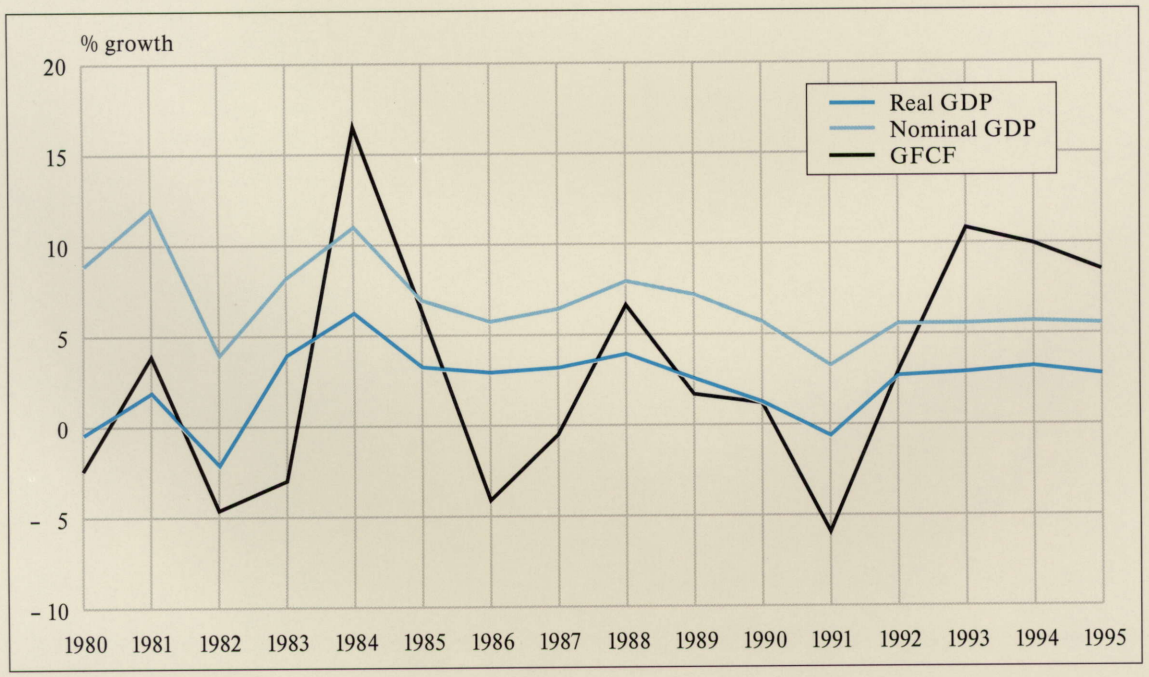
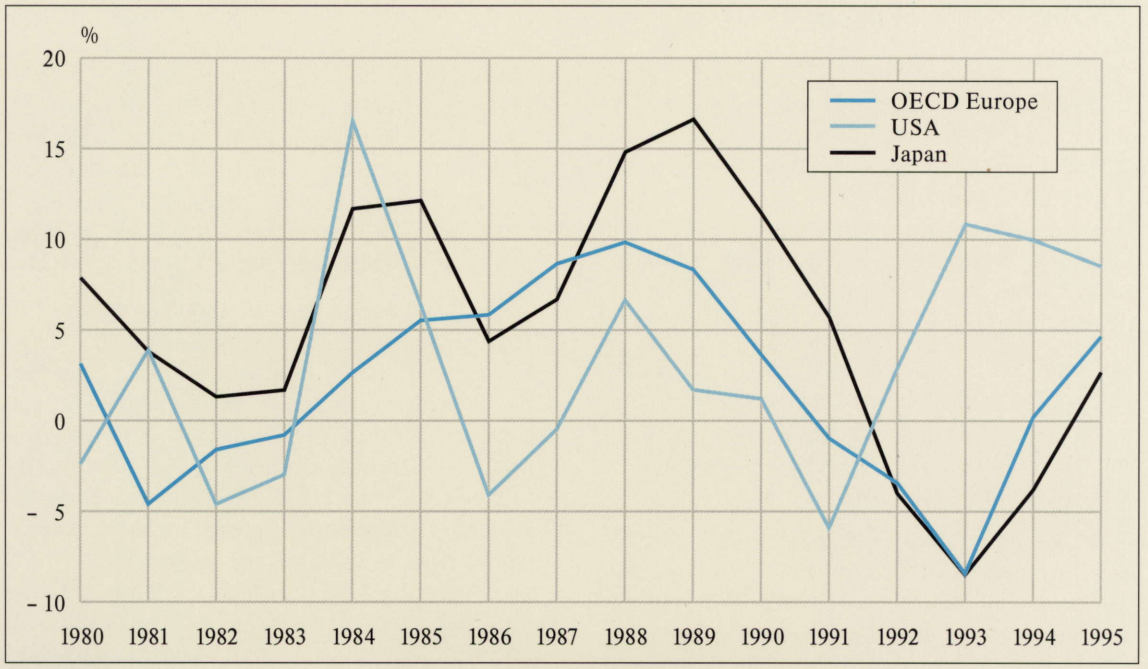


Figure 3
Economic Growth in the USA, 1980-1995

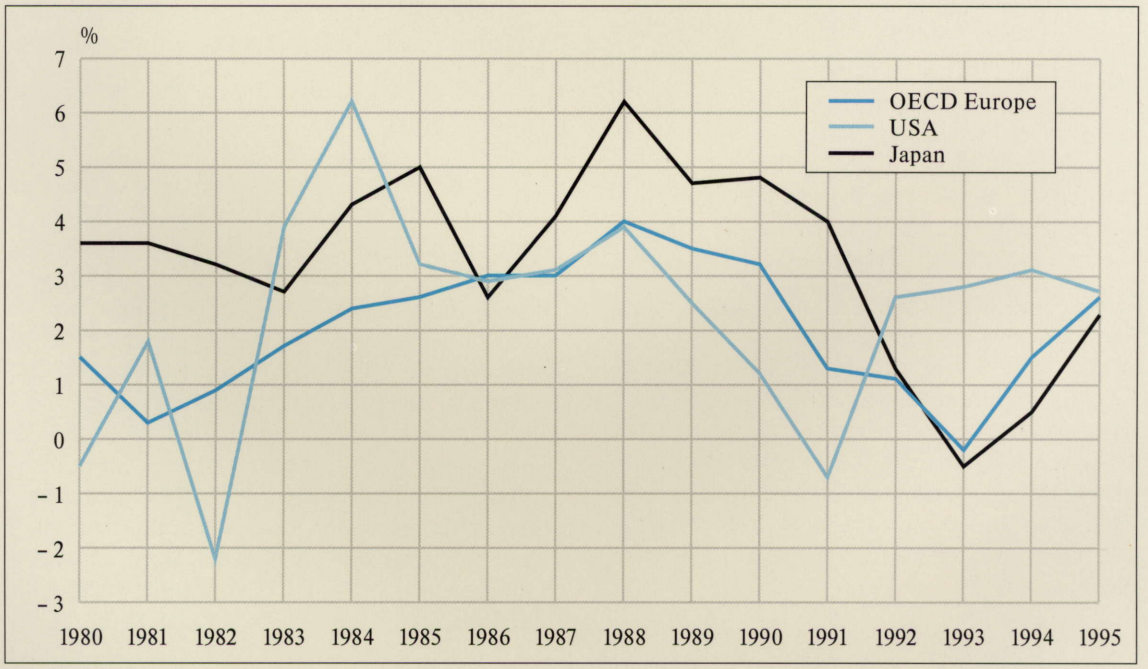
Source: OECD, December 1993

Figure 4
Growth of Gross Private Non-residential Fixed Capital Formation in OECD Europe, the USA, Japan, 1980-1995



Source: OECD, December 1993

Figure 5
Growth of Real Gross Domestic Product in OECD Europe, the USA, Japan, 1980-1995



Source: OECD, December 1993

7. International ICT Markets

In 1993 the worldwide ICT market within the definitions of this study totalled ECUs 775 billion. The IT market alone accounted for some 45% of it. This figure represents 5.4% growth of the ICT market measured in constant ECUs. The IT market registered a 3.7% expansion. After adjusting for exchange rates, the overall ICT market grew by 12.2%, while the IT market expanded by 10.4%.

The US IT recovery and progressive ECU devaluation against the US Dollar have led to the result that for the first time in over two decades, the US IT market gained share as a proportion of all ICT and IT spending.

In 1993 the US ICT market grew 7.0%, or 15.3% accounting for exchange rate variations. In 1992 growth at constant ECUs was 7.7%, while it was only 2.4% at prevailing exchange rates for each year. The European ICT market (including Eastern Europe) grew by 4.4% in 1993, while the IT market expanded by 2.4% (or 2.0% excluding Eastern Europe).

Cyclical economic changes outside of the US are accelerating secular changes in the industry, such as: maturation of the multi-user systems market, falling prices for PCs, and the shift from building budgets around new hardware to focusing on software and services.

The European and Japanese markets were particularly vulnerable because:
i) their price floors were much higher than the US, and so had further to fall;
ii) growth has been so much stronger than in the US in the past few years, that users had a cushion of recently acquired products to fall back upon when they began to feel the consequences of the worst economic crisis in twenty years in Japan or half a century in Europe.

The rapid growth of European IT markets which was so much a feature of the past decade and more, came to a sudden halt in the early 1990s. The manner in which the European IT markets decelerated is well illustrated in *figure 7.* One side effect of the new growth paradigm, enabled to a large extent by the dismantling of political barriers between Eastern & Western Europe, has been an increased interest in new markets.

Industry executives and those professionally engaged in monitoring the IT industry have been made increasingly aware of the close ties between the fortunes of the industry and the general economic health of the major buying nations. Although during some phases of the rapid development of the IT industry, economic weakness has acted as a catalyst for sales, as companies have automated manual functions, this is no longer the case. Europe's IT markets today find themselves in a very difficult position, with economic recession aggravating structural weaknesses. In addition, the prospect of de-regulation of European telecommunications markets in the coming years adds to a feeling of nervousness.

The 1993 market for communications and information technology products in Western Europe is valued at ECU 262 billion. Of this, ECU 226 billion is attributed to EU member states, and the remaining ECU 36 billion is attributed to EFTA states (for the purposes of this study, Iceland and Liechtenstein are not included). Czechoslovakia, Poland, Hungary and the former Soviet Union (not included in the Western European total quoted above) considered together would add a further ECU 13 billion to the total. By 1995 the combination of the EU and EFTA market forecasts is expected to reach ECU 290 billion, an increase of ECU 28 billion over two years; but Eastern European markets are only expected to offer an addition opportunity equivalent to ECU 3 billion over the same period. *Table 9* shows the overall value of the ICT markets in the various EU and EFTA states

over the study period. The relative proportions that the EFTA, EU and Eastern European states comprise of the total continental IT market are illustrated in *figure 11*. More detailed information on the ICT market value in the major regions and the individual countries, including comprehensive details by class of product, are given in *tables 4* to *35*. Supplementary data on the number of units shipped are given, where available, in *tables 36* to *59*.

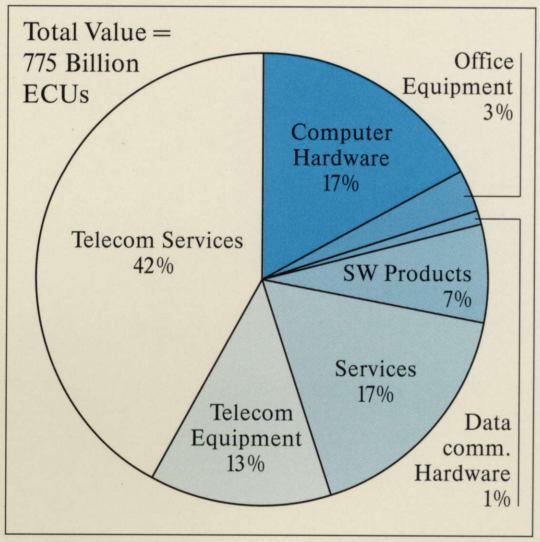
Over the two year period to the end of 1995, the European telecommunications market is expected to grow at a compound annual rate of 6.3 %, compared to 3.9 % for the IT market. Thus, by 1995 the telecommunications market will account for 55 % of the total ICT market. Within the telecommunications market the vast majority of revenues are derived from voice network services, a situation which is not expected to change during the period under discussion.

By contrast, the largest proportion of the 1993 IT market is attributed to various classes of IT services (office services or servicing of office equipment is expressly not included in this study). These categories will comprise 19 % of the total ICT market in 1993. The next largest sector is computer hardware, which comprises 15 % of the 1993 total, followed by software products, 8 % of the 1993 total, and finally, office equipment with 3 % of the total.

Even over the two year period from 1993 to 1995, the European IT market is expected to experience a continuing transformation in its overall disposition. Differential growth is forecast for the software and service sectors of the market place relative to hardware, leading to the IT market proportions illustrated in *figure 12*. The change in market proportions illustrated over this relatively short period of time is part of a longer term process, which has already seen the software and services sectors increase their share of the total considerably over the past five years.

The compound annual growth rates for the major classes of ICT business from 1993 to 1995 are shown in *figure 8*, and detailed examination of the forecasts presented will reveal that although overall growth prospects are limited, there are product or service oriented segments of the market place where considerable growth can be expected. This fact emphasises the importance of past strategic decisions in determining the short term growth potential for vendors currently active in Europe, and on a longer time scale, the challenges of profitably reorienting the business to meet the changing requirements of the market place.

Figure 6
Worldwide ICT Market by Product, 1993



Source: EITO

		1991	1992	1993	1994	1995
IT	Europe *)	118,059	120,891	123,743	128,788	134,886
	US	118,572	127,678	136,582	146,059	155,318
	Japan	62,519	58,107	55,911	58,280	61,093
	ROW	28,263	31,119	34,105	38,659	44,094
	Total	**327,412**	**337,794**	**350,341**	**371,785**	**395,392**
ICT	Europe *)	251,471	263,626	275,269	289,987	306,234
	US	251,240	268,940	287,061	305,825	323,953
	Japan	126,038	125,042	125,986	131,675	138,153
	ROW	66,589	78,067	87,025	98,174	110,513
	Total	**695,339**	**735,675**	**775,341**	**825,660**	**878,853**
		% growth				
IT	Europe *)		2.4	2.4	4.1	4.7
	US		7.7	7.0	6.9	6.3
	Japan		- 7.1	- 3.8	4.2	4.8
	ROW		10.1	9.6	13.4	14.1
	Total		**3.2**	**3.7**	**6.1**	**6.3**
ICT	Europe *)		4.8	4.4	5.3	5.6
	US		7.0	6.7	6.5	5.9
	Japan		- 0.8	0.8	4.5	4.9
	ROW		17.2	11.5	12.8	12.6
	Total		**3.2**	**3.7**	**6.1**	**6.3**
		% breakdown				
IT	Europe *)	36.1	35.8	35.3	34.6	34.1
	US	36.2	37.8	39.0	39.3	39.3
	Japan	19.1	17.2	16.0	15.7	15.5
	ROW	8.6	9.2	9.7	10.4	11.2
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
ICT	Europe *)	36.2	35.8	35.5	35.1	34.8
	US	36.1	36.6	37.0	37.0	36.9
	Japan	18.1	17.0	16.2	15.9	15.7
	ROW	9.6	10.6	11.2	11.9	12.6
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*) includes Eastern Europe

Table 4
Worldwide IT and ICT Market Growth Trends. Market Value. Million ECUs at Constant 1992 Exchange Rates

Table 5
Worldwide IT and ICT Market Growth Trends. Market Value. Million ECUs at Current Exchange Rates

		1991	1992	1993	1994	1995
IT	Europe *)	118,059	120,891	123,743	128,788	134,886
	US	124,731	127,678	147,225	157,061	167,018
	Japan	61,952	58,107	67,100	71,341	74,785
	ROW	29,690	31,119	34,731	39,305	44,794
	Total	**334,433**	**337,794**	**372,798**	**396,494**	**421,483**
ICT	Europe *)	251,471	263,626	275,269	289,987	306,234
	US	264,292	268,940	309,430	328,861	348,355
	Japan	124,897	125,042	151,197	161,184	169,115
	ROW	70,872	78,067	89,342	100,576	113,090
	Total	**711,532**	**735,675**	**825,238**	**880,608**	**936,793**
		% growth				
IT	Europe *)		2.4	2.0	5.5	5.7
	US		2.4	15.3	6.7	6.3
	Japan		- 6.2	15.5	6.3	4.8
	ROW		4.8	11.6	13.2	14.0
	Total		**1.0**	**10.4**	**6.4**	**6.3**
ICT	Europe *)		4.8	4.4	5.3	5.6
	US		1.8	15.1	6.3	5.9
	Japan		0.1	20.9	6.6	4.9
	ROW		10.2	14.4	12.6	12.4
	Total		**3.4**	**12.2**	**6.7**	**6.4**
		% breakdown				
IT	Europe *)	35.3	35.8	33.2	32.5	32.0
	US	37.3	37.8	39.5	39.6	39.6
	Japan	18.5	17.2	18.0	18.0	17.7
	ROW	8.9	9.2	9.3	9.9	10.6
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
ICT	Europe *)	35.3	35.8	33.4	32.9	32.7
	US	37.1	36.6	37.5	37.3	37.2
	Japan	17.6	17.0	18.3	18.3	18.1
	ROW	10.0	10.6	10.8	11.4	12.1
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*) includes Eastern Europe

	1991	1992	1993	1994
$	1.23	1.29	1.20	1.21
Yen	166.10	163.87	137.11	134.42

Source: OECD

Table 6
ECU/$ and ECU/Yen Exchange Rates, 1991-1994

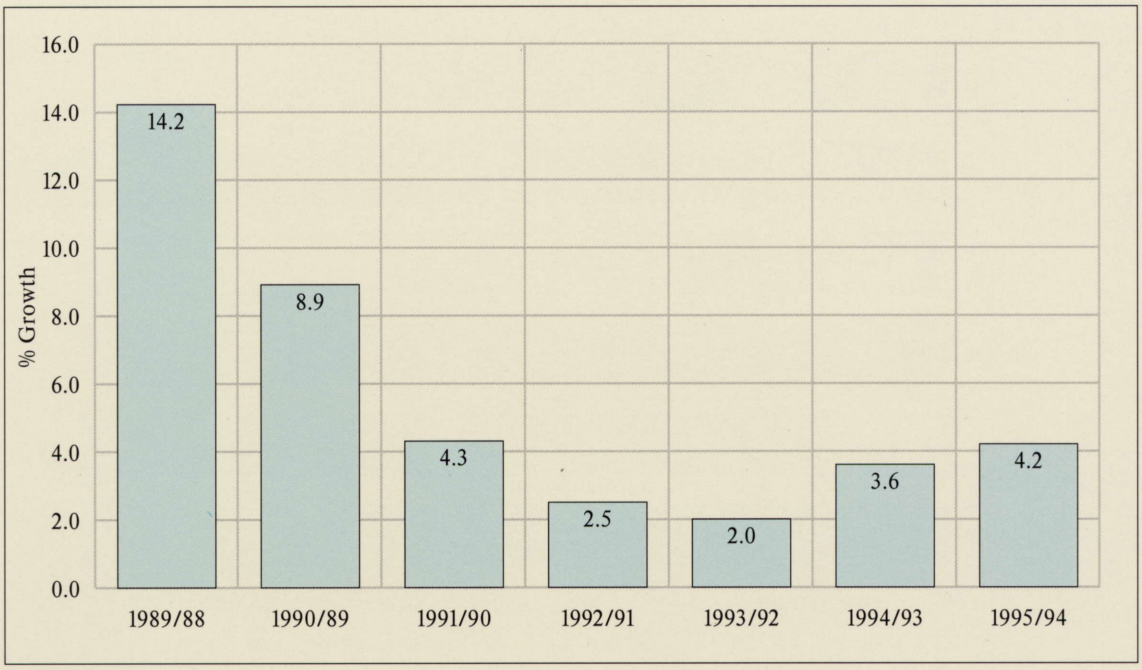
1993	Europe	East. Eur.	US	Japan	ROW	World
IT Hardware	51,434	1,727	66,337	27,559	20,413	167,471
Software	19,985	348	24,671	4,933	4,849	54,787
IT Services	49,359	889	45,574	23,419	8,842	128,083
Telecom Equipment	29,127	4,181	36,938	17,792	13,664	101,702
Telecom Services	111,884	6,334	113,541	52,283	39,257	323,299
Total	**261,789**	**13,480**	**287,061**	**125,986**	**87,026**	**775,341**
1995	Europe	East. Eur.	US	Japan	ROW	World
IT Hardware	53,403	2,648	70,059	29,476	23,503	179,088
Software	23,102	654	31,385	6,942	7,216	69,298
IT Services	53,866	1,214	53,874	24,676	13,375	147,005
Telecom Equipment	27,801	4,564	42,468	18,131	18,337	111,300
Telecom Services	131,449	7,534	126,167	58,929	48,083	372,161
Total	**289,620**	**16,614**	**323,953**	**138,153**	**110,513**	**878,853**

Table 7
Major Regional ICT Markets by Product, 1993 and 1995, Million ECUs

1993	Europe	East. Eur.	US	Japan	ROW	World
IT Hardware	1.9	23.8	2.8	3.4	7.3	3.4
Software	7.5	37.1	12.8	18.6	22.0	12.5
IT Services	4.5	16.8	8.7	2.6	23.0	7.1
IT	3.9	23.4	6.6	4.5	13.7	6.2
Telecom Equipment	-2.3	4.5	7.2	0.9	15.8	4.6
Telecom Services	8.4	9.1	5.4	6.2	10.7	7.3
Telecom	6.3	7.3	5.9	4.9	12.0	6.7
Total	**5.2**	**11.0**	**6.2**	**4.7**	**12.7**	**6.5**

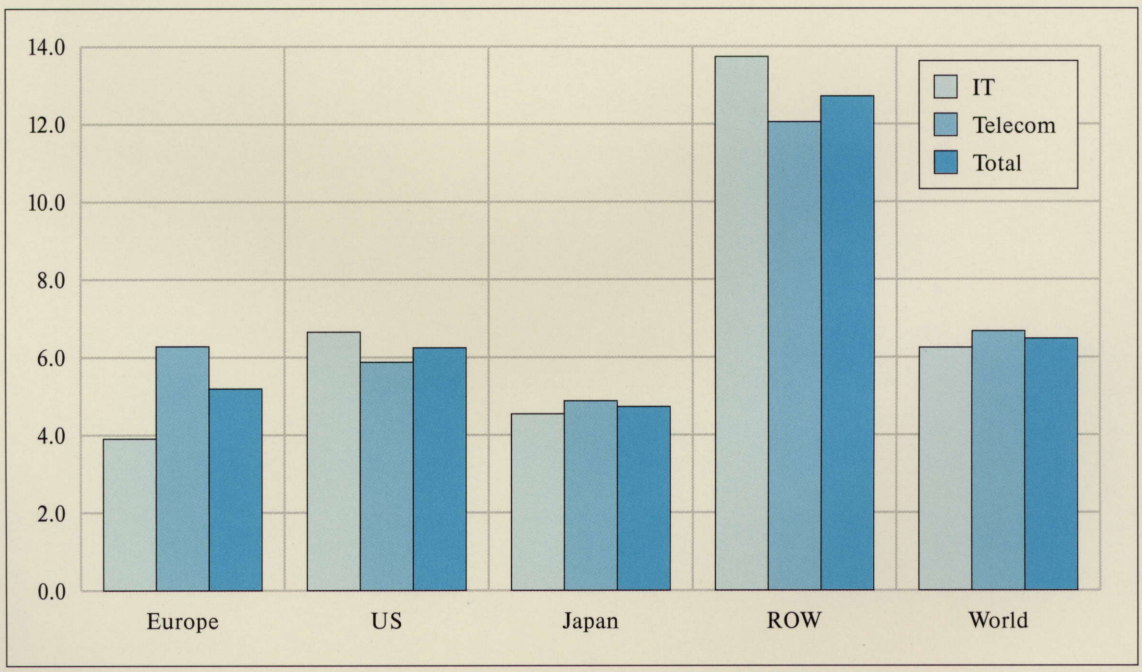
Table 8
Major Regional ICT Markets by Product, 1993.
% Average Annual Growth in Value, 1993

Figure 7
EU + EFTA IT Market. Annual Growth, 1988-1995



Source: EITO

Figure 8
World ICT Market. Average Annual Growth in %, 1993-1995



Source: EITO

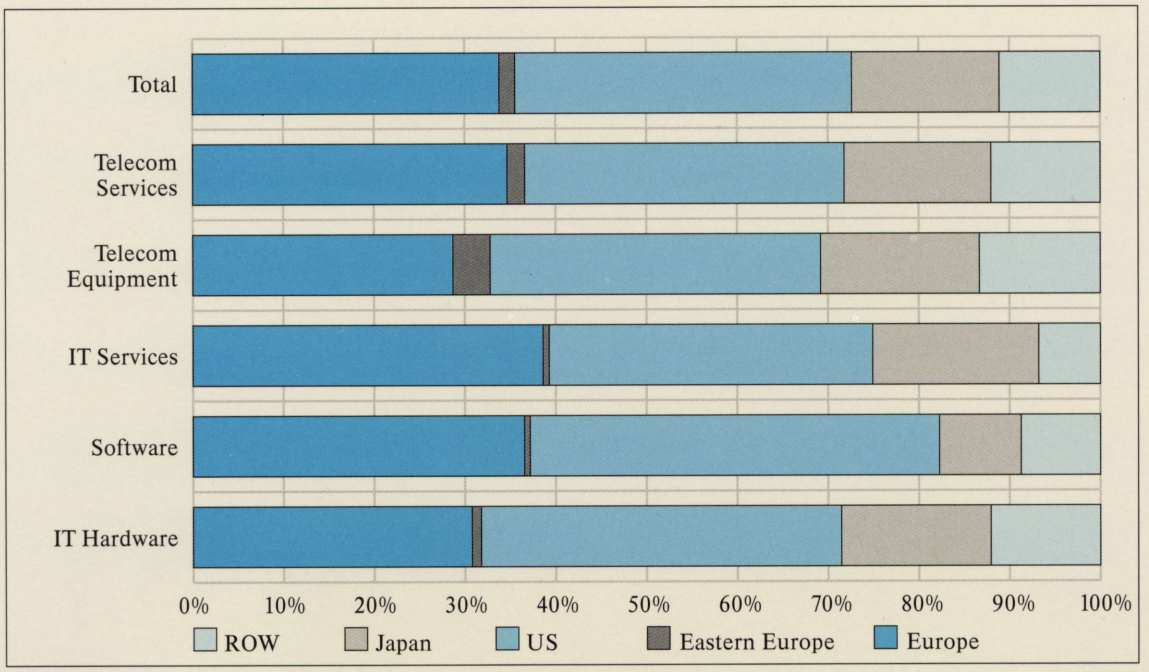


Figure 9
World ICT Market.
Regional Proportions
by Product, 1993

Source: EITO

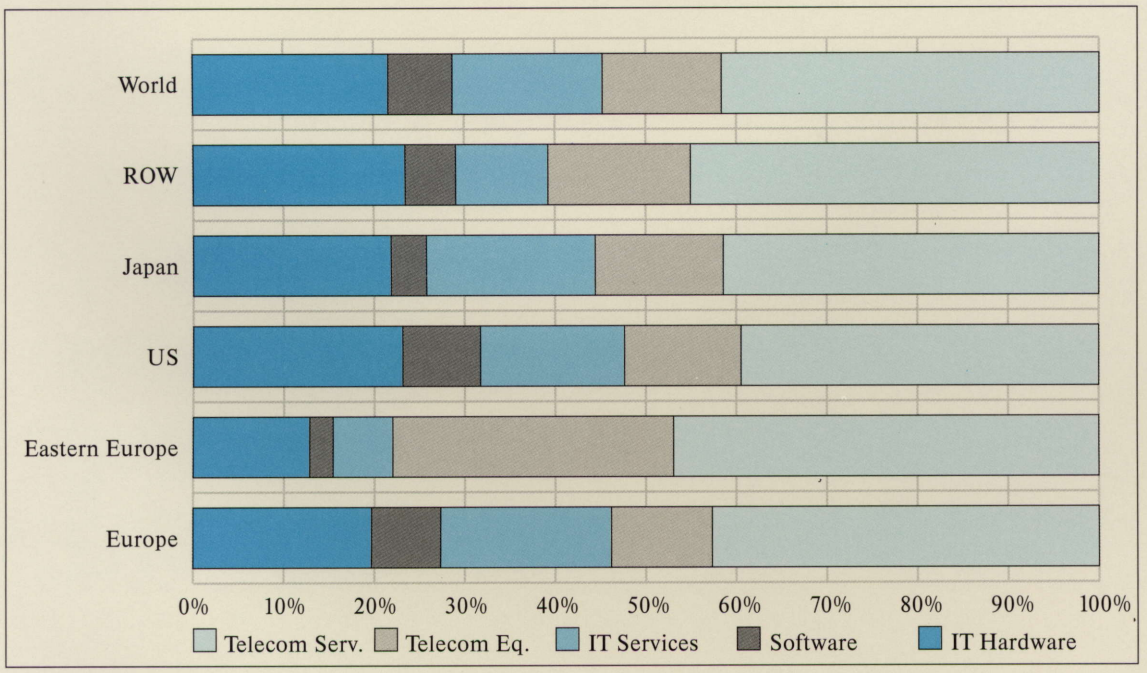
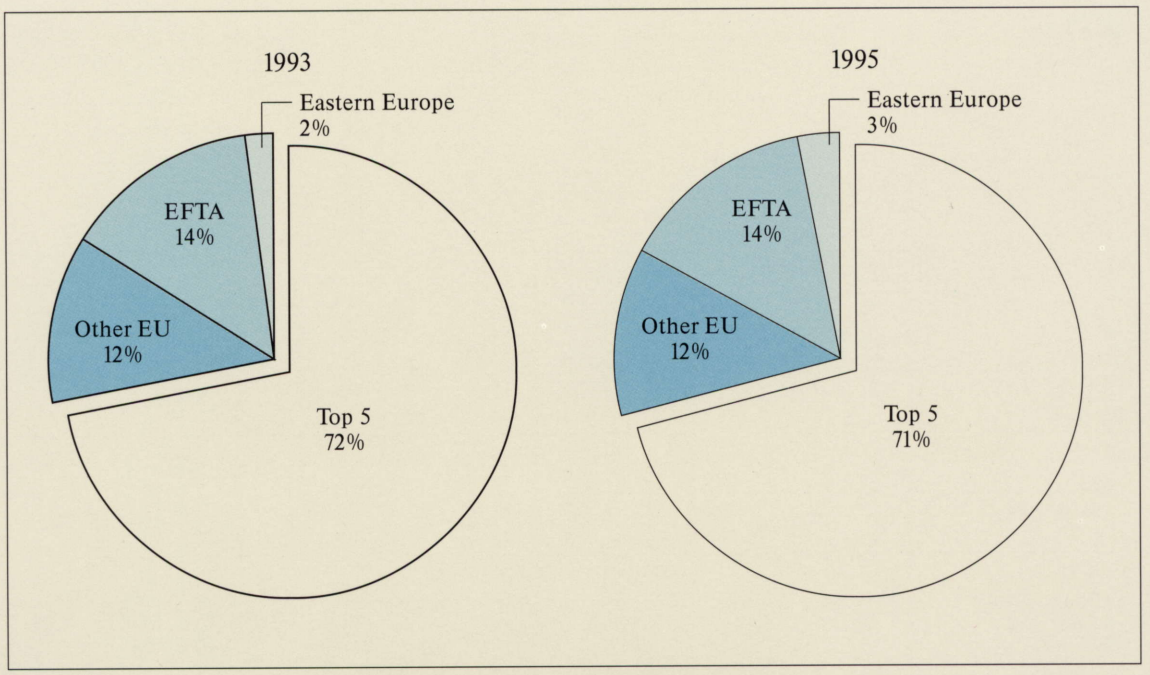


Figure 10
World ICT Market.
Product Proportions
by Region, 1993

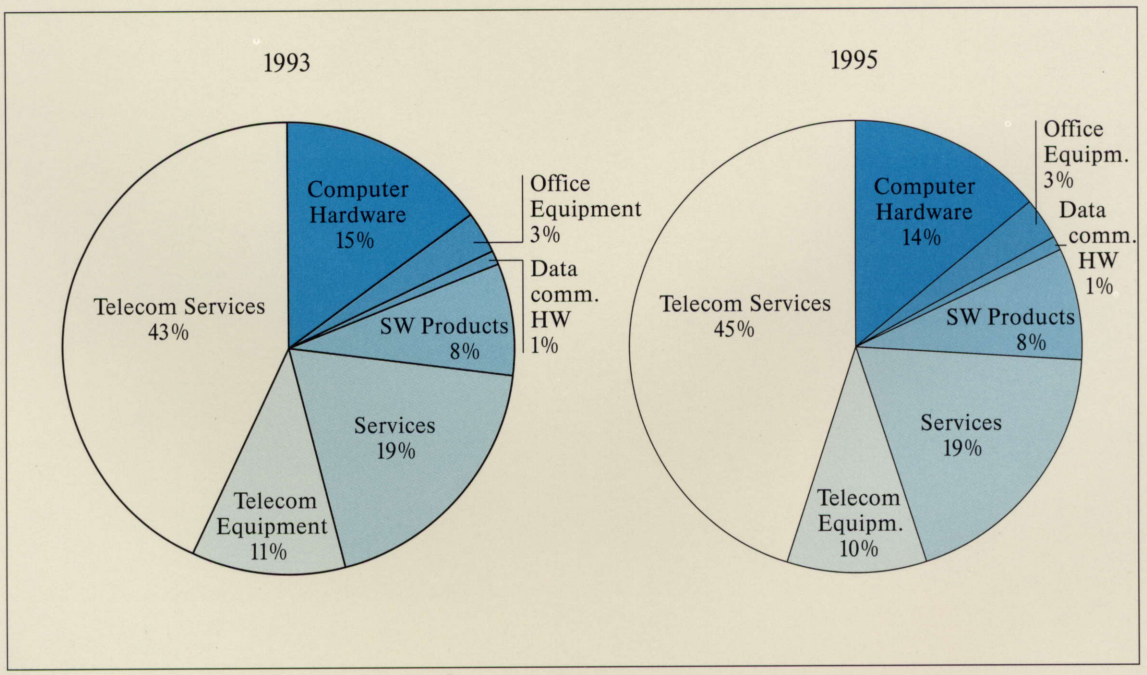
Source: EITO

Figure 11
European IT Markets by Region, 1993 and 1995



Source: EITO

Figure 12
EU + EFTA ICT Market Proportions by Class of Business, 1993 and 1995



Source: EITO

ICT Market by Country	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Austria	4,957	5,332	5,716	6,118	6,522	7.4	6.8
Belgium/Luxembourg	6,584	6,882	7,269	7,576	7,912	5.1	4.3
Denmark	5,104	5,205	5,596	5,936	6,261	4.7	5.8
Finland	3,159	3,097	3,273	3,460	3,624	1.8	5.2
France	39,572	41,301	42,519	44,445	46,478	3.7	4.6
Germany	57,234	62,502	65,626	69,569	74,299	7.1	6.4
Greece	1,494	1,601	1,715	1,845	1,998	7.1	8.0
Ireland	1,693	1,768	1,825	1,871	1,922	3.8	2.6
Italy	27,982	29,451	30,578	32,055	33,676	4.5	4.9
Netherlands	11,245	11,574	12,170	12,875	13,593	4.0	5.7
Norway	4,335	4,493	4,749	5,013	5,242	4.7	5.1
Portugal	1,479	1,708	1,929	2,170	2,408	14.2	11.7
Spain	14,956	15,037	15,276	16,075	17,010	1.1	5.5
Sweden	10,637	10,625	11,195	11,642	12,157	2.6	4.2
Switzerland	10,323	10,757	11,177	11,653	12,225	4.1	4.6
UK	38,885	39,960	41,176	42,767	44,292	2.9	3.7

Table 9
ICT Market by Country (Million ECUs)

IT Market by Country	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Austria	2,204	2,310	2,427	2,575	2,713	5.0	5.7
Belgium/Luxembourg	3,632	3,681	3,820	3,885	3,971	2.6	2.0
Denmark	2,937	2,860	3,045	3,172	3,287	1.8	3.9
Finland	1,930	1,772	1,869	1,983	2,088	- 1.6	5.7
France	20,255	20,756	20,660	21,107	21,750	1.0	2.6
Germany	27,431	28,863	29,290	30,293	31,678	3.3	4.0
Greece	381	448	526	625	750	17.5	19.4
Ireland	600	641	677	714	759	6.2	5.8
Italy	12,602	12,896	12,863	13,105	13,446	1.0	2.2
Netherlands	5,859	5,879	6,123	6,455	6,767	2.2	5.1
Norway	2,384	2,343	2,427	2,498	2,574	0.9	3.0
Portugal	649	775	900	1,057	1,236	17.7	17.2
Spain	5,688	5,621	5,450	5,665	6,004	- 2.1	5.0
Sweden	5,263	4,977	5,328	5,546	5,768	0.6	4.1
Switzerland	4,829	4,991	5,126	5,305	5,587	3.0	4.4
UK	18,975	19,649	20,245	21,135	21,993	3.3	4.2

Table 10
IT Market by Country (Million ECUs)

Table 11
Telecommunications Market by Country (Million ECUs)

Telecommunications Market by Country	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Austria	2,753	3,023	3,288	3,543	3,809	9.3	7.6
Belgium/Luxembourg	2,952	3,200	3,449	3,691	3,941	8.1	6.9
Denmark	2,166	2,345	2,552	2,764	2,974	8.5	8.0
Finland	1,228	1,325	1,404	1,477	1,536	6.9	4.6
France	19,317	20,545	21,859	23,339	24,728	6.4	6.4
Germany	29,802	33,639	36,335	39,275	42,621	10.4	8.3
Greece	1,113	1,153	1,188	1,219	1,248	3.3	2.5
Ireland	1,093	1,127	1,148	1,157	1,163	2.5	0.7
Italy	15,380	16,556	17,715	18,950	20,230	7.3	6.9
Netherlands	5,385	5,696	6,047	6,421	6,827	6.0	6.2
Norway	1,951	2,151	2,322	2,516	2,667	9.1	7.2
Portugal	830	933	1,029	1,113	1,172	11.4	6.7
Spain	9,268	9,415	9,825	10,411	11,006	3.0	5.8
Sweden	5,374	5,648	5,867	6,095	6,388	4.5	4.3
Switzerland	5,495	5,767	6,052	6,348	6,638	4.9	4.7
UK	19,910	20,311	20,932	21,631	22,299	2.5	3.2

Austria	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	134	133	117	99	84	- 6.5	- 15.3
Medium	146	126	115	105	98	- 11.2	- 7.7
Small	159	123	182	193	198	6.8	4.4
Workstations	44	50	57	66	77	13.8	15.9
PCs - portable	37	56	62	69	76	28.5	10.8
PCs - desktop	210	231	214	240	265	0.9	11.4
PC printers	118	114	111	112	112	- 3.1	0.6
Computer hardware	**848**	**834**	**857**	**883**	**909**	**0.5**	**3.0**
Typewriters	14	13	13	11	10	- 6.2	- 10.6
Calculators	14	13	13	12	12	- 2.6	- 4.0
Copiers	61	66	64	64	66	2.7	1.5
Other office equipment	45	49	46	46	46	1.1	0.5
Office equipment	**134**	**141**	**136**	**133**	**134**	**0.7**	**- 0.4**
LAN hardware	18	26	30	34	35	27.5	8.7
Other data communications	27	25	26	27	28	- 1.6	4.3
Data communications hardware	**45**	**51**	**56**	**60**	**63**	**11.2**	**6.7**
IT hardware	**1,027**	**1,025**	**1,048**	**1,077**	**1,107**	**1.0**	**2.8**
Systems software	213	237	262	291	315	10.9	9.6
Application software	158	181	206	246	277	14.3	15.8
Software products	**371**	**418**	**469**	**538**	**592**	**12.4**	**12.4**
Professional services	351	389	424	460	497	9.8	8.3
Processing services	157	164	171	177	185	4.3	4.0
Network services	21	24	28	32	35	15.5	13.0
Hardware maintenance & support services	276	289	288	291	297	2.2	1.5
Services	**805**	**866**	**910**	**961**	**1,014**	**6.3**	**5.5**
Total IT market	**2,204**	**2,310**	**2,427**	**2,575**	**2,713**	**5.0**	**5.7**
Service providing equipment	402	397	390	382	374	- 1.5	- 2.0
Customer premises equipment	160	174	183	187	193	6.9	2.5
Data Network Services	283	343	394	440	482	18.1	10.5
Voice network services	1,865	2,062	2,273	2,485	2,710	10.4	9.2
Installation & maintenance	43	45	48	50	51	4.9	3.5
Total telecom	**2,753**	**3,023**	**3,288**	**3,543**	**3,809**	**9.3**	**7.6**
Total ICT	**4,957**	**5,332**	**5,716**	**6,118**	**6,522**	**7.4**	**6.8**

Table 12
Austria
ICT Market Value
(Million ECUs)

Table 13
Belgium/Luxembourg
ICT Market Value
(Million ECUs)

Belgium/Luxembourg	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	239	216	197	166	142	- 9.3	- 15.2
Medium	180	166	165	149	138	- 4.4	- 8.5
Small	179	151	204	216	222	6.6	4.2
Workstations	55	55	63	72	85	6.8	16.7
PCs - portable	75	89	115	116	123	24.1	3.3
PCs - desktop	429	383	374	361	348	- 6.6	- 3.6
PC printers	169	166	164	166	166	- 1.7	0.8
Computer hardware	**1,327**	**1,227**	**1,282**	**1,246**	**1,224**	**- 1.7**	**- 2.3**
Typewriters	23	20	17	15	15	- 14.4	- 7.3
Calculators	18	16	17	16	16	- 2.8	- 3.1
Copiers	105	119	116	120	123	4.9	3.2
Other office equipment	74	79	78	79	81	2.1	2.2
Office equipment	**220**	**234**	**227**	**231**	**235**	**1.5**	**1.7**
LAN hardware	33	43	52	56	57	26.1	4.1
Other data communications	36	35	37	38	39	1.7	3.0
Data communications hardware	**68**	**78**	**89**	**94**	**96**	**14.0**	**3.7**
IT hardware	**1,616**	**1,539**	**1,598**	**1,571**	**1,554**	**- 0.6**	**- 1.4**
Systems software	332	368	380	395	414	7.1	4.4
Application software	207	230	241	253	270	7.9	5.7
Software products	**539**	**598**	**621**	**648**	**684**	**7.4**	**4.9**
Professional services	665	705	745	786	829	5.8	5.5
Processing services	346	356	367	378	386	3.0	2.6
Network services	37	43	48	52	59	13.7	11.4
Hardware maintenance & support services	429	441	442	450	458	1.5	1.8
Services	**1,477**	**1,544**	**1,601**	**1,666**	**1,733**	**4.1**	**4.0**
Total IT market	**3,632**	**3,681**	**3,820**	**3,885**	**3,971**	**2.6**	**2.0**
Service providing equipment	393	370	352	338	325	- 5.4	- 3.9
Customer premises equipment	257	269	276	284	292	3.5	2.9
Data network services	183	235	281	321	353	24.0	12.1
Voice network services	2,044	2,249	2,460	2,665	2,887	9.7	8.3
Installation & maintenance	74	77	81	83	85	4.1	2.6
Total telecom	**2,952**	**3,200**	**3,449**	**3,691**	**3,941**	**8.1**	**6.9**
Total ICT	**6,584**	**6,882**	**7,269**	**7,576**	**7,912**	**5.1**	**4.3**

Denmark	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	203	140	159	139	115	- 11.5	- 15.2
Medium	133	102	108	98	90	- 10.0	- 8.6
Small	116	92	133	142	145	7.0	4.2
Workstations	28	28	29	31	34	2.2	7.6
PCs - portable	72	63	69	76	84	- 2.1	10.2
PCs - desktop	342	304	300	307	311	- 6.5	1.9
PC printers	112	105	108	108	107	- 1.9	- 0.2
Computer hardware	**1,007**	**835**	**906**	**901**	**886**	**- 5.2**	**- 1.1**
Typewriters	12	10	10	9	8	- 9.3	- 8.0
Calculators	15	13	13	12	11	- 6.0	- 6.2
Copiers	63	70	71	76	81	6.2	6.4
Other office equipment	49	50	50	50	50	1.0	0.8
Office equipment	**138**	**143**	**144**	**147**	**151**	**1.9**	**2.4**
LAN hardware	55	64	70	75	76	12.7	4.1
Other data communications	29	32	34	36	36	7.2	3.5
Data communications hardware	**85**	**95**	**104**	**110**	**113**	**10.8**	**3.9**
IT hardware	**1,230**	**1,074**	**1,154**	**1,158**	**1,149**	**- 3.2**	**- 0.2**
Systems software	186	204	219	230	242	8.6	5.1
Application software	181	199	216	233	249	9.4	7.4
Software products	**367**	**403**	**435**	**463**	**491**	**9.0**	**6.2**
Professional services	640	655	684	724	749	3.4	4.6
Processing services	427	452	496	546	604	7.8	10.3
Network services	54	60	64	71	82	8.9	13.5
Hardware maintenance & support services	219	216	211	210	211	- 1.9	0.0
Services	**1,340**	**1,383**	**1,455**	**1,550**	**1,647**	**4.2**	**6.4**
Total IT market	**2,937**	**2,860**	**3,045**	**3,172**	**3,287**	**1.8**	**3.9**
Service providing equipment	119	123	123	121	119	1.9	- 1.9
Customer premises equipment	229	237	249	258	268	4.1	3.8
Data network services	147	196	244	285	318	29.0	14.2
Voice network services	1,611	1,727	1,872	2,033	2,201	7.8	8.4
Installation & maintenance	61	62	64	67	69	3.1	3.5
Total telecom	**2,166**	**2,345**	**2,552**	**2,764**	**2,974**	**8.5**	**8.0**
Total ICT	**5,104**	**5,205**	**5,596**	**5,936**	**6,261**	**4.7**	**5.8**

Table 14
Denmark
ICT Market Value
(Million ECUs)

Table 15
Finland
ICT Market Value
(Million ECUs)

Finland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	83	37	58	49	39	- 16.7	- 17.5
Medium	82	65	52	47	43	- 19.9	- 9.3
Small	96	58	94	99	102	- 1.2	4.4
Workstations	25	21	21	22	23	- 8.5	4.1
PCs - portable	43	38	45	53	66	2.5	20.5
PCs - desktop	283	227	227	269	318	- 10.5	18.5
PC printers	70	67	63	66	69	- 5.2	5.0
Computer hardware	**683**	**513**	**560**	**604**	**661**	**- 9.4**	**8.6**
Typewriters	9	8	7	6	5	- 15.4	- 10.2
Calculators	11	10	10	9	9	- 5.5	- 6.3
Copiers	47	48	48	50	51	2.1	2.6
Other office equipment	32	35	32	33	33	1.0	1.4
Office equipment	**99**	**100**	**97**	**97**	**98**	**- 0.7**	**0.5**
LAN hardware	37	47	58	62	65	25.5	5.8
Other data communications	53	58	63	64	67	9.5	2.8
Data communications hardware	**89**	**105**	**121**	**127**	**132**	**16.3**	**4.3**
IT hardware	**871**	**718**	**779**	**828**	**891**	**- 5.4**	**7.0**
Systems software	126	119	126	135	139	0.0	5.0
Application software	132	129	140	152	162	3.0	7.6
Software products	**259**	**249**	**267**	**288**	**302**	**1.6**	**6.4**
Professional services	419	412	420	450	463	0.2	5.0
Processing services	214	223	236	250	261	5.1	5.1
Network services	19	22	23	25	29	9.5	12.5
Hardware maintenance & support services	149	149	145	142	142	- 1.6	- 0.9
Services	**801**	**805**	**824**	**867**	**895**	**1.4**	**4.2**
Total IT market	**1,930**	**1,772**	**1,869**	**1,983**	**2,088**	**- 1.6**	**5.7**
Service providing equipment	172	164	156	149	143	- 5.0	- 4.0
Customer premises equipment	254	266	276	284	290	4.2	2.6
Data network services	126	144	164	184	197	14.1	9.5
Voice network services	612	686	742	793	838	10.1	6.3
Installation & maintenance	64	65	66	67	68	1.9	1.2
Total telecom	**1,228**	**1,325**	**1,404**	**1,477**	**1,536**	**6.9**	**4.6**
Total ICT	**3,159**	**3,097**	**3,273**	**3,460**	**3,624**	**1.8**	**5.2**

France	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	1,215	1,153	953	797	695	- 11.4	- 14.6
Medium	1,009	1,003	802	728	691	- 10.9	- 7.1
Small	845	895	852	899	912	0.5	3.4
Workstations	327	344	379	418	466	7.7	10.9
PCs - portable	429	519	443	375	373	1.6	- 8.2
PCs - desktop	2,492	2,109	2,051	2,021	2,092	- 9.3	1.0
PC printers	752	719	701	715	721	- 3.4	1.5
Computer hardware	**7,068**	**6,742**	**6,181**	**5,952**	**5,951**	**- 6.5**	**- 1.9**
Typewriters	122	104	91	76	70	- 13.7	- 12.0
Calculators	104	107	95	89	85	- 4.4	- 5.5
Copiers	604	686	665	698	740	4,9	5,5
Other office equipment	423	492	437	441	463	1.7	2.9
Office equipment	**1,253**	**1,389**	**1,287**	**1,304**	**1,357**	**1.4**	**2.7**
LAN hardware	189	234	284	315	339	22.6	9.3
Other data communications	259	302	329	341	340	12.6	1.7
Data communications hardware	**448**	**536**	**613**	**656**	**680**	**16.9**	**5.3**
IT hardware	**8,769**	**8,667**	**8,081**	**7,912**	**7,988**	**- 4.0**	**- 0.6**
Systems software	1,684	1,820	1,915	2,031	2,165	6.6	6.3
Application software	1,054	1,198	1,284	1,391	1,514	10.4	8.6
Software products	**2,738**	**3,018**	**3,198**	**3,422**	**3,679**	**8.1**	**7.3**
Professional services	4,444	4,743	4,958	5,232	5,405	5.6	4.4
Processing services	1,414	1,471	1,519	1,551	1,579	3.6	1.9
Network services	181	203	235	283	340	13.9	20.2
Hardware maintenance & support services	2,709	2,655	2,668	2,708	2,760	- 0.8	1.7
Services	**8,749**	**9,072**	**9,380**	**9,773**	**10,083**	**3.5**	**3.7**
Total IT market	**20,255**	**20,756**	**20,660**	**21,107**	**21,750**	**1.0**	**2.6**
Service providing equipment	1,550	1,339	1,232	1,207	1,207	- 10.8	- 1.0
Customer premises equipment	1,737	1,782	1,838	1,894	1,940	2.9	2.7
Data network services	1,805	2,233	2,554	2,879	3,043	19.0	9.2
Voice network services	13,694	14,654	15,688	16,800	17,974	7.0	7.0
Installation & maintenance	531	537	547	558	564	1.6	1.5
Total telecom	**19,317**	**20,545**	**21,859**	**23,339**	**24,728**	**6.4**	**6.4**
Total ICT	**39,572**	**41,301**	**42,519**	**44,445**	**46,478**	**3.7**	**4.6**

Table 16
France
ICT Market Value
(Million ECUs)

Table 17
Germany
ICT Market Value
(Million ECUs)

Germany	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	2,465	2,274	1,819	1,637	1,555	- 14.1	- 7.5
Medium	1,276	1,235	1,007	956	937	- 11.2	- 3.5
Small	1,340	1,182	1,235	1,300	1,412	- 4.0	6.9
Workstations	548	552	618	710	832	6.2	16.0
PCs - portable	558	710	789	850	885	18.8	5.9
PCs - desktop	3,090	3,208	3,330	3,745	4,163	3.8	11.8
PC printers	1,290	1,272	1,253	1,253	1,252	- 1.4	0.0
Computer hardware	**10,567**	**10,434**	**10,049**	**10,451**	**11,037**	**- 2.5**	**4.8**
Typewriters	350	334	270	222	188	- 12.2	- 16.5
Calculators	237	258	237	222	210	0.0	- 5.8
Copiers	1,166	1,135	1,124	1,135	1,152	- 1.8	1.2
Other office equipment	602	791	801	815	831	15.3	1.8
Office equipment	**2,355**	**2,517**	**2,432**	**2,395**	**2,382**	**1.6**	**- 1.0**
LAN hardware	246	346	430	480	519	32.2	9.9
Other data communications	158	183	202	208	209	13.1	1.9
Data communications hardware	**404**	**529**	**632**	**688**	**728**	**25.1**	**7.4**
IT hardware	**13,326**	**13,481**	**13,113**	**13,534**	**14,147**	**- 0.8**	**3.9**
Systems software	2,102	2,349	2,517	2,646	2,800	9.4	5.5
Application software	1,574	1,806	1,975	2,114	2,282	12.0	7.5
Software products	**3,676**	**4,154**	**4,492**	**4,759**	**5,082**	**10.5**	**6.4**
Professional services	5,010	5,561	5,922	6,219	6,560	8.7	5.3
Processing services	1,928	2,027	2,113	2,164	2,239	4.7	2.9
Network services	152	178	205	231	263	16.2	13.4
Hardware maintenance & support services	3,340	3,462	3,445	3,386	3,386	1.6	- 0.9
Services	**10,429**	**11,228**	**11,685**	**12,000**	**12,449**	**5.8**	**3.2**
Total IT market	**27,431**	**28,863**	**29,290**	**30,293**	**31,678**	**3.3**	**4.0**
Service providing equipment	5,469	6,260	5,965	5,751	5,946	4.4	- 0.2
Customer premises equipment	2,108	2,262	2,407	2,542	2,656	6.9	5.1
Data network services	3,978	4,679	5,244	5,846	6,354	14.8	10.1
Voice network services	17,599	19,756	22,004	24,388	26,892	11.8	10.6
Installation & maintenance	649	682	715	748	773	5.0	4.0
Total telecom	**29,802**	**33,639**	**36,335**	**39,275**	**42,621**	**10.4**	**8.3**
Total ICT	**57,234**	**62,502**	**65,626**	**69,569**	**74,299**	**7.1**	**6.4**

Greece	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	15	16	18	20	22	8.7	10.4
Medium	18	20	22	26	30	11.8	15.7
Small	26	28	32	37	44	12.0	16.3
Workstations	8	9	11	12	15	15.0	16.5
PCs - portable	7	9	11	14	18	30.2	26.0
PCs - desktop	75	87	100	114	129	15.2	13.7
PC printers	28	33	39	47	57	18.6	20.3
Computer hardware	**177**	**202**	**234**	**271**	**314**	**15.0**	**15.9**
Typewriters	10	11	11	11	11	4.4	- 0.6
Calculators	6	7	7	8	8	6.9	2.9
Copiers	47	48	48	49	49	1.0	1.1
Other office equipment	33	34	35	35	35	2.7	1.2
Office equipment	**96**	**100**	**101**	**103**	**103**	**2.3**	**1.1**
LAN hardware	4	5	6	7	7	31.9	6.7
Other data communications	4	4	4	4	4	11.3	- 0.9
Data communications hardware	**7**	**9**	**11**	**11**	**11**	**22.0**	**3.6**
IT hardware	**280**	**312**	**345**	**384**	**428**	**11.0**	**11.4**
Systems software	16	23	30	41	56	38.2	35.9
Application software	27	38	53	72	98	40.7	36.7
Software products	**42**	**61**	**83**	**113**	**154**	**39.8**	**36.4**
Professional services	35	47	63	87	121	34.0	38.4
Processing services	9	13	17	20	24	36.6	17.3
Network services	1	1	1	1	1	19.5	18.3
Hardware maintenance & support services	14	15	17	19	22	11.7	12.2
Services	**59**	**75**	**98**	**128**	**168**	**29.4**	**30.5**
Total IT market	**381**	**448**	**526**	**625**	**750**	**17.5**	**19.4**
Service providing equipment	147	150	152	152	149	1.6	- 1.0
Customer premises equipment	54	56	59	60	62	4.0	2.9
Data network services	29	33	36	39	41	11.3	6.7
Voice network services	864	894	921	947	975	3.3	2.9
Installation & maintenance	19	19	20	21	21	3.6	3.2
Total telecom	**1,113**	**1,153**	**1,188**	**1,219**	**1,248**	**3.3**	**2.5**
Total ICT	**1,494**	**1,601**	**1,715**	**1,845**	**1,998**	**7.1**	**8.0**

Table 18
Greece
ICT Market Value
(Million ECUs)

Table 19
Ireland
ICT Market Value
(Million ECUs)

Ireland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	31	33	34	35	37	5.1	3.5
Medium	62	65	69	71	73	5.1	3.5
Small	93	98	103	106	110	5.1	3.5
Workstations	8	9	10	11	12	11.2	8.2
PCs - portable	7	8	9	10	11	15.3	6.2
PCs - desktop	52	48	43	42	43	- 9.4	- 0.2
PC printers	18	18	19	20	21	4.4	4.5
Computer hardware	**271**	**279**	**287**	**294**	**307**	**2.9**	**3.3**
Typewriters	13	13	13	11	10	- 1.3	- 12.5
Calculators	10	10	10	10	11	1.9	3.5
Copiers	62	64	64	63	61	1.8	- 2.5
Other office equipment	43	44	45	45	43	1.5	- 1.9
Office equipment	**128**	**131**	**132**	**130**	**125**	**1.4**	**- 2.8**
LAN hardware	6	9	11	11	12	34.0	4.2
Other data communications	8	9	10	10	9	9.5	- 1.6
Data communications hardware	**14**	**18**	**20**	**21**	**21**	**20.6**	**1.5**
IT hardware	**414**	**428**	**440**	**445**	**452**	**3.1**	**1.4**
Systems software	20	23	25	28	31	10.0	12.5
Application software	47	56	64	74	85	15.9	15.2
Software products	**68**	**78**	**88**	**101**	**116**	**14.2**	**14.5**
Professional services	42	50	57	67	78	16.1	17.0
Processing services	26	28	29	31	33	5.6	6.8
Network services	2	2	2	3	3	13.4	8.2
Hardware maintenance & support services	48	55	60	67	76	12.0	12.2
Services	**119**	**134**	**149**	**168**	**190**	**12.2**	**13.0**
Total IT market	**600**	**641**	**677**	**714**	**759**	**6.2**	**5.8**
Service providing equipment	64	65	66	66	64	1.8	- 1.8
Customer premises equipment	73	69	65	62	60	- 6.0	- 3.6
Data network services	59	64	67	71	73	7.1	4.0
Voice network services	872	903	923	932	939	2.9	0.9
Installation & maintenance	25	26	26	27	27	2.9	1.3
Total telecom	**1,093**	**1,127**	**1,148**	**1,157**	**1,163**	**2.5**	**0.7**
Total ICT	**1,693**	**1,768**	**1,825**	**1,871**	**1,922**	**3.8**	**2.6**

Italy	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	648	504	423	362	345	- 19.2	- 9.7
Medium	764	721	584	541	499	- 12.5	- 7.6
Small	806	808	846	880	895	2.4	2.9
Workstations	146	152	157	175	195	3.9	11.3
PCs - portable	188	208	228	265	305	10.2	15.5
PCs - desktop	1,286	1,105	1,095	1,152	1,174	- 7.7	3.6
PC printers	424	413	376	357	337	- 5.8	- 5.4
Computer hardware	**4,261**	**3,911**	**3,710**	**3,732**	**3,750**	**- 6.7**	**0.5**
Typewriters	86	66	49	37	29	- 25.1	- 22.5
Calculators	75	72	65	61	57	- 7.1	- 6.3
Copiers	457	476	463	468	477	0.7	1.5
Other office equipment	306	379	349	360	382	6.9	4.6
Office equipment	**925**	**992**	**926**	**925**	**945**	**0.1**	**1.0**
LAN hardware	68	92	109	119	125	26.8	7.2
Other data communications	93	90	89	86	82	- 2.4	- 3.9
Data communications hardware	**161**	**182**	**197**	**205**	**207**	**10.8**	**2.3**
IT hardware	**5,347**	**5,084**	**4,833**	**4,862**	**4,902**	**- 4.9**	**0.7**
Systems software	1,385	1,468	1,494	1,512	1,540	3.9	1.5
Application software	921	1,013	1,043	1,087	1,154	6.4	5.2
Software products	**2,306**	**2,481**	**2,537**	**2,600**	**2,694**	**4.9**	**3.0**
Professional services	2,778	3,075	3,203	3,306	3,455	7.4	3.9
Processing services	730	762	755	762	773	1.7	1.2
Network services	300	337	369	400	437	10.8	8.8
Hardware maintenance & support services	1,141	1,156	1,166	1,175	1,185	1.1	0.8
Services	**4,949**	**5,330**	**5,492**	**5,643**	**5,850**	**5.3**	**3.2**
Total IT market	**12,602**	**12,896**	**12,863**	**13,105**	**13,446**	**1.0**	**2.2**
Service providing equipment	2,425	2,152	1,933	1,783	1,640	- 10.7	- 7.9
Customer premises equipment	1,133	1,068	1,014	963	915	- 5.4	- 5.0
Data network services	261	402	526	646	751	42.0	19.6
Voice network services	11,267	12,626	13,923	15,229	16,590	11.2	9.2
Installation & maintenance	294	308	319	329	335	4.2	2.3
Total telecom	**15,380**	**16,556**	**17,715**	**18,950**	**20,230**	**7.3**	**6.9**
Total ICT	**27,982**	**29,451**	**30,578**	**32,055**	**33,676**	**4.5**	**4.9**

Table 20
Italy
ICT Market Value
(Million ECUs)

Table 21
Netherlands
ICT Market Value
(Million ECUs)

Netherlands	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	280	225	204	167	139	- 14.6	- 17.4
Medium	357	273	297	283	272	- 8.8	- 4.4
Small	209	264	226	232	233	4.0	1.5
Workstations	109	104	118	130	136	3.7	7.5
PCs - portable	104	125	156	175	193	22.2	11.3
PCs - desktop	881	639	652	710	774	- 13.9	8.9
PC printers	246	238	234	236	233	- 2.6	- 0.2
Computer hardware	**2,186**	**1,869**	**1,886**	**1,932**	**1,979**	**- 7.1**	**2.4**
Typewriters	48	46	41	35	33	- 7.0	- 10.6
Calculators	37	35	34	34	33	- 3.3	- 1.2
Copiers	266	285	285	288	294	3.5	1.5
Other office equipment	178	203	181	183	185	1.0	1.0
Office equipment	**528**	**569**	**542**	**540**	**545**	**1.3**	**0.3**
LAN hardware	78	98	119	129	133	23.7	5.6
Other data communications	71	79	86	89	90	10.4	2.1
Data communications hardware	**149**	**177**	**205**	**219**	**223**	**17.6**	**4.2**
IT hardware	**2,863**	**2,615**	**2,633**	**2,690**	**2,747**	**- 4.1**	**2.1**
Systems software	619	681	722	787	855	8.0	8.8
Application software	468	525	580	666	736	11.4	12.6
Software products	**1,087**	**1,207**	**1,302**	**1,452**	**1,591**	**9.5**	**10.5**
Professional services	783	852	906	948	981	7.6	4.1
Processing services	559	580	601	617	634	3.7	2.7
Network services	55	59	62	67	71	6.1	6.6
Hardware maintenance & support services	513	565	619	681	743	9.9	9.5
Services	**1,910**	**2,056**	**2,188**	**2,313**	**2,429**	**7.0**	**5.4**
Total IT market	**5,859**	**5,879**	**6,123**	**6,455**	**6,767**	**2.2**	**5.1**
Service providing equipment	929	875	840	806	774	- 4.9	- 4.0
Customer premises equipment	616	642	670	693	713	4.3	3.1
Data network services	294	331	358	383	408	10.3	6.8
Voice network services	3,356	3,654	3,980	4,336	4,725	8.9	9.0
Installation & maintenance	189	194	199	203	207	2.5	2.0
Total telecom	**5,385**	**5,696**	**6,047**	**6,421**	**6,827**	**6.0**	**6.2**
Total ICT	**11,245**	**11,574**	**12,170**	**12,875**	**13,593**	**4.0**	**5.7**

Norway	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	63	51	52	44	36	- 8.9	- 16.9
Medium	75	69	59	53	50	- 11.5	- 7.5
Small	75	62	84	89	91	5.5	4.0
Workstations	43	43	45	49	54	2.7	9.2
PCs - portable	80	63	58	58	57	- 14.7	- 1.1
PCs - desktop	379	308	271	252	253	- 15.4	- 3.4
PC printers	77	74	76	75	75	- 0.5	- 0.9
Computer hardware	**793**	**669**	**646**	**620**	**616**	**- 9.7**	**- 2.3**
Typewriters	10	9	9	8	8	- 6.1	- 5.0
Calculators	12	11	11	11	11	- 3.0	- 2.8
Copiers	54	55	57	59	61	2.6	3.8
Other office equipment	39	40	40	41	41	1.0	1.0
Office equipment	**115**	**115**	**117**	**118**	**121**	**0.8**	**1.6**
LAN hardware	41	53	65	69	71	26.1	4.8
Other data communications	35	40	44	45	42	11.9	- 1.9
Data communications hardware	**76**	**93**	**109**	**114**	**113**	**19.7**	**2.1**
IT hardware	**983**	**877**	**871**	**852**	**850**	**- 5.9**	**- 1.2**
Systems software	174	179	187	195	204	3.6	4.4
Application software	161	170	179	190	202	5.4	6.2
Software products	**335**	**349**	**366**	**384**	**405**	**4.5**	**5.3**
Professional services	488	517	556	593	621	6.8	5.6
Processing services	349	368	400	434	460	7.0	7.3
Network services	45	49	55	60	66	10.6	10.1
Hardware maintenance & support services	184	183	180	175	172	- 1.3	- 2.2
Services	**1,066**	**1,117**	**1,190**	**1,261**	**1,320**	**5.7**	**5.3**
Total IT market	**2,384**	**2,343**	**2,427**	**2,498**	**2,574**	**0.9**	**3.0**
Service providing equipment	279	333	350	343	339	12.1	- 1.7
Customer premises equipment	103	116	118	120	122	6.9	1.9
Data network services	65	80	95	111	126	21.2	14.7
Voice network services	1,453	1,569	1,703	1,882	2,019	8.3	8.9
Installation & maintenance	52	53	56	59	61	4.1	4.7
Total telecom	**1,951**	**2,151**	**2,322**	**2,516**	**2,667**	**9.1**	**7.2**
Total ICT	**4,335**	**4,493**	**4,749**	**5,013**	**5,242**	**4.7**	**5.1**

Table 22
Norway
ICT Market Value
(Million ECUs)

Table 23
Portugal
ICT Market Value
(Million ECUs)

Portugal	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	122	146	171	201	241	18.1	19.0
Medium	66	78	94	114	136	19.0	20.5
Small	83	99	118	143	170	19.5	20.0
Workstations	11	14	18	22	29	25.1	28.0
PCs - portable	2	2	3	4	6	36.5	39.1
PCs - desktop	21	25	30	37	43	19.0	20.7
PC printers	22	27	32	38	48	19.5	22.0
Computer hardware	**327**	**391**	**464**	**560**	**672**	**19.1**	**20.4**
Typewriters	11	11	12	12	12	1.2	2.6
Calculators	7	8	8	9	9	4.7	6.7
Copiers	52	53	55	56	57	3.0	1.5
Other office equipment	36	37	38	39	40	3.0	2.2
Office equipment	**106**	**109**	**113**	**116**	**118**	**2.9**	**2.2**
LAN hardware	7	10	12	13	14	29.6	8.2
Other data communications	13	15	17	17	17	14.8	- 0.7
Data communications hardware	**20**	**25**	**29**	**30**	**31**	**20.3**	**3.1**
IT hardware	**454**	**525**	**606**	**706**	**821**	**15.6**	**16.4**
Systems software	35	45	57	74	92	27.1	27.6
Application software	53	67	85	111	138	27.1	27.6
Software products	**88**	**112**	**142**	**184**	**231**	**27.1**	**27.6**
Professional services	74	93	93	93	93	11.7	0.0
Processing services	17	25	34	42	51	41.5	21.8
Network services	1	1	2	2	2	15.6	13.0
Hardware maintenance & support services	15	19	23	30	37	25.3	26.5
Services	**108**	**137**	**152**	**167**	**184**	**18.9**	**9.8**
Total IT market	**649**	**775**	**900**	**1,057**	**1,236**	**17.7**	**17.2**
Service providing equipment	230	233	229	223	219	- 0.2	- 2.4
Customer premises equipment	67	76	82	85	86	10.0	2.8
Data network services	83	96	106	113	119	12.8	5.8
Voice network services	423	499	579	656	710	17.0	10.7
Installation & maintenance	25	29	33	37	39	13.7	8.6
Total telecom	**830**	**933**	**1,029**	**1,113**	**1,172**	**11.4**	**6.7**
Total ICT	**1,479**	**1,708**	**1,929**	**2,170**	**2,408**	**14.2**	**11.7**

Spain	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	421	310	267	223	203	- 20.4	- 12.9
Medium	309	248	223	200	189	- 15.1	- 7.7
Small	427	428	438	447	474	1.3	4.0
Workstations	67	88	107	131	173	26.1	27.2
PCs - portable	175	190	151	165	178	- 7.2	8.6
PCs - desktop	1,159	971	766	851	875	- 18.7	6.8
PC printers	310	283	257	240	228	- 8.8	- 5.8
Computer hardware	**2,868**	**2,518**	**2,208**	**2,257**	**2,318**	**- 12.2**	**2.5**
Typewriters	57	53	47	41	34	- 9.0	- 15.5
Calculators	43	45	41	41	40	- 1.8	- 1.8
Copiers	274	299	293	284	286	3.5	- 1.3
Other office equipment	188	229	202	191	192	3.6	- 2.4
Office equipment	**562**	**626**	**584**	**556**	**552**	**1.9**	**- 2.8**
LAN hardware	50	61	75	83	90	22.8	9.8
Other data communications	50	57	60	60	60	9.3	0.2
Data communications hardware	**99**	**118**	**134**	**144**	**150**	**16.2**	**5.6**
IT hardware	**3,530**	**3,262**	**2,927**	**2,957**	**3,020**	**- 8.9**	**1.6**
Systems software	438	471	497	526	596	6.5	9.6
Application software	295	336	359	383	447	10.3	11.6
Software products	**733**	**807**	**855**	**909**	**1,043**	**8.0**	**10.4**
Professional services	650	724	794	884	987	10.6	11.5
Processing services	151	158	164	170	176	4.2	3.7
Network services	23	27	31	35	39	15.5	11.8
Hardware maintenance & support services	601	643	679	710	738	6.3	4.3
Services	**1,425**	**1,552**	**1,668**	**1,799**	**1,940**	**8.2**	**7.8**
Total IT market	**5,688**	**5,621**	**5,450**	**5,665**	**6,004**	**- 2.1**	**5.0**
Service providing equipment	3,165	2,533	2,153	1,894	1,667	- 17.5	- 12.0
Customer premises equipment	663	701	728	750	765	4.8	2.5
Data network services	668	795	890	968	1,032	15.5	7.7
Voice network services	4,553	5,160	5,818	6,554	7,294	13.0	12.0
Installation & maintenance	219	228	236	244	248	3.7	2.6
Total telecom	**9,268**	**9,415**	**9,825**	**10,411**	**11,006**	**3.0**	**5.8**
Total ICT	**14,956**	**15,037**	**15,276**	**16,075**	**17,010**	**1.1**	**5.5**

Table 24
Spain
ICT Market Value
(Million ECUs)

Table 25
Sweden
ICT Market Value
(Million ECUs)

Sweden	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	226	112	173	149	128	- 12.4	- 14.1
Medium	169	120	146	132	122	- 7.1	- 8.8
Small	149	149	166	175	181	5.3	4.5
Workstations	90	80	82	86	92	- 4.9	6.4
PCs - portable	145	122	144	151	167	- 0.1	7.5
PCs - desktop	609	516	467	453	459	- 12.4	- 0.9
PC printers	148	141	139	140	139	- 3.0	0.1
Computer hardware	**1,536**	**1,239**	**1,317**	**1,285**	**1,288**	**- 7.4**	**- 1.1**
Typewriters	21	19	17	15	14	- 10.0	- 8.0
Calculators	22	21	20	20	19	- 4.0	- 4.5
Copiers	110	112	113	117	120	1.4	2.9
Other office equipment	80	82	83	84	86	2.1	1.7
Office equipment	**233**	**235**	**234**	**236**	**239**	**0.1**	**1.1**
LAN hardware	76	97	114	123	128	22.8	5.9
Other data communications	56	64	69	70	68	11.5	- 1.2
Data communications hardware	**131**	**161**	**184**	**193**	**196**	**18.2**	**3.3**
IT hardware	**1,901**	**1,635**	**1,735**	**1,714**	**1,723**	**- 4.5**	**- 0.3**
Systems software	343	362	388	410	434	6.3	5.8
Application software	331	356	389	419	452	8.4	7.8
Software products	**675**	**718**	**777**	**829**	**886**	**7.3**	**6.8**
Professional services	1,649	1,588	1,771	1,950	2,088	3.6	8.6
Processing services	534	545	563	586	606	2.7	3.8
Network services	55	59	72	77	86	13.7	9.7
Hardware maintenance & support services	449	433	411	391	379	- 4.4	- 3.9
Services	**2,687**	**2,625**	**2,816**	**3,004**	**3,159**	**2.4**	**5.9**
Total IT market	**5,263**	**4,977**	**5,328**	**5,546**	**5,768**	**0.6**	**4.1**
Service providing equipment	673	586	539	509	471	- 10.5	- 6.5
Customer premises equipment	770	753	730	708	763	- 2.6	2.2
Data network services	260	295	324	358	386	11.6	9.2
Voice network services	3,478	3,817	4,075	4,319	4,566	8.2	5.8
Installation & maintenance	193	197	199	202	203	1.7	0.9
Total telecom	**5,374**	**5,648**	**5,867**	**6,095**	**6,388**	**4.5**	**4.3**
Total ICT	**10,637**	**10,625**	**11,195**	**11,642**	**12,157**	**2.6**	**4.2**

Switzerland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	360	296	303	263	222	- 8.2	- 14.5
Medium	216	169	182	162	151	- 8.2	- 8.9
Small	198	191	220	233	241	5.5	4.6
Workstations	118	104	114	126	140	- 1.7	10.9
PCs - portable	198	195	179	177	201	- 5.0	6.2
PCs - desktop	612	688	584	552	592	- 2.3	0.7
PC printers	227	220	214	224	227	- 2.9	2.9
Computer hardware	**1,929**	**1,864**	**1,796**	**1,738**	**1,774**	**- 3.5**	**- 0.6**
Typewriters	31	27	25	22	21	- 10.4	- 6.6
Calculators	24	23	23	22	22	- 2.4	- 1.6
Copiers	136	143	144	150	156	3.0	4.1
Other office equipment	96	110	98	101	103	1.0	2.4
Office equipment	**287**	**302**	**290**	**296**	**303**	**0.5**	**2.2**
LAN hardware	51	66	84	94	100	28.9	8.8
Other data communications	35	38	40	41	41	6.8	1.4
Data communications hardware	**86**	**103**	**124**	**135**	**141**	**20.4**	**6.5**
IT hardware	**2,302**	**2,269**	**2,210**	**2,168**	**2,217**	**- 2.0**	**0.2**
Systems software	462	503	549	604	673	9.0	10.7
Application software	407	449	498	558	635	10.7	12.9
Software products	**869**	**952**	**1,047**	**1,162**	**1,308**	**9.8**	**11.8**
Professional services	693	768	834	903	976	9.7	8.2
Processing services	273	279	286	296	285	2.4	- 0.1
Network services	126	136	153	172	189	10.2	11.0
Hardware maintenance & support services	566	588	596	605	611	2.5	1.3
Services	**1,658**	**1,770**	**1,868**	**1,975**	**2,061**	**6.1**	**5.0**
Total IT market	**4,829**	**4,991**	**5,126**	**5,305**	**5,587**	**3.0**	**4.4**
Service providing equipment	1,543	1,399	1,273	1,171	1,077	- 9.2	- 8.0
Customer premises equipment	316	335	354	371	381	6.0	3.8
Data network services	165	209	235	244	253	19.6	3.6
Voice network services	3,378	3,727	4,089	4,458	4,821	10.0	8.6
Installation & maintenance	94	97	100	103	105	3.4	2.4
Total telecom	**5,495**	**5,767**	**6,052**	**6,348**	**6,638**	**4.9**	**4.7**
Total ICT	**10,323**	**10,757**	**11,177**	**11,653**	**12,225**	**4.1**	**4.6**

Table 26
Switzerland
ICT Market Value
(Million ECUs)

Table 27
United Kingdom
ICT Market Value
(Million ECUs)

United Kingdom	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	964	1,064	746	655	574	- 12.0	- 12.3
Medium	1,100	841	792	723	659	- 15.1	- 8.8
Small	802	795	780	810	822	- 1.4	2.7
Workstations	364	374	409	473	551	6.0	16.1
PCs - portable	510	607	753	877	1,022	21.5	16.5
PCs - desktop	2,123	2,289	2,439	2,494	2,568	7.2	2.6
PC printers	772	764	748	768	774	- 1.6	1.7
Computer hardware	**6,635**	**6,733**	**6,668**	**6,800**	**6,971**	**0.2**	**2.3**
Typewriters	135	117	112	96	89	- 8.8	- 11.2
Calculators	105	111	105	105	106	- 0.1	0.8
Copiers	670	722	721	721	753	3.7	2.2
Other office equipment	463	539	467	462	457	0.4	- 1.1
Office equipment	**1,374**	**1,489**	**1,405**	**1,384**	**1,405**	**1.1**	**0.0**
LAN hardware	285	416	499	533	548	32.3	4.8
Other data communications	480	477	490	506	481	1.0	- 0.8
Data communications hardware	**765**	**892**	**988**	**1,039**	**1,029**	**13.6**	**2.0**
IT hardware	**8,774**	**9,115**	**9,061**	**9,224**	**9,406**	**1.6**	**1.9**
Systems software	1,794	1,772	1,894	2,023	2,163	2.8	6.9
Application software	1,235	1,297	1,411	1,537	1,679	6.9	9.1
Software products	**3,029**	**3,069**	**3,305**	**3,561**	**3,842**	**4.5**	**7.8**
Professional services	3,801	3,995	4,336	4,711	4,978	6.8	7.1
Processing services	1,053	1,086	1,110	1,133	1,146	2.6	1.6
Network services	200	249	295	336	380	21.4	13.6
Hardware maintenance & support services	2,118	2,135	2,138	2,171	2,241	0.5	2.4
Services	**7,172**	**7,465**	**7,879**	**8,351**	**8,745**	**4.8**	**5.4**
Total IT market	**18,975**	**19,649**	**20,245**	**21,135**	**21,993**	**3.3**	**4.2**
Service providing equipment	3,674	2,830	2,437	2,194	1,997	- 18.6	- 9.5
Customer premises equipment	2,002	1,957	1,890	1,840	1,785	- 2.8	- 2.8
Data network services	2,952	3,089	3,187	3,297	3,344	3.9	2.4
Voice network services	10,602	11,713	12,654	13,497	14,337	9.2	6.4
Installation & maintenance	680	722	764	804	837	6.0	4.7
Total telecom	**19,910**	**20,311**	**20,932**	**21,631**	**22,299**	**2.5**	**3.2**
Total ICT	**38,885**	**39,960**	**41,176**	**42,767**	**44,292**	**2.9**	**3.7**

Czech & Slovak Republics	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	8	15	19	25	31	55.0	27.8
Medium	7	25	27	26	28	90.9	2.1
Small	23	36	42	47	57	35.4	16.4
Workstations	4	15	16	18	21	102.5	14.8
PCs - portable	4	9	10	13	18	66.8	35.2
PCs - desktop	85	169	154	174	207	34.4	16.0
PC printers	45	80	84	98	113	37.3	15.7
Computer hardware	**176**	**349**	**352**	**400**	**475**	**41.5**	**16.2**
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	25	32	39	41	49	24.5	12.6
Other office equipment	12	20	24	27	32	41.4	15.7
Office equipment	**37**	**53**	**63**	**68**	**81**	**30.2**	**13.8**
LAN hardware	4	5	6	6	8	25.8	18.1
Data communications hardware	**4**	**5**	**6**	**6**	**8**	**25.8**	**18.1**
IT hardware	**216**	**407**	**421**	**475**	**564**	**39.4**	**15.8**
Systems software	19	36	42	49	57	50.6	16.3
Application software	16	30	36	42	49	50.6	16.3
Software products	**35**	**66**	**79**	**91**	**106**	**50.6**	**16.3**
Professional services	45	55	70	81	94	25.0	15.8
Other services	47	58	69	79	92	21.2	16.1
Services	**92**	**113**	**139**	**159**	**186**	**23.1**	**16.0**
Total IT market	**343**	**587**	**638**	**725**	**857**	**36.5**	**15.9**

Table 28
Czech & Slovak Republics
ICT Market Value
(Million ECUs)

Table 29
Hungary
ICT Market Value
(Million ECUs)

Hungary	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	4	7	7	9	9	21.9	18.1
Medium	13	29	32	22	19	58.6	- 23.6
Small	11	21	22	23	23	41.9	2.8
Workstations	2	6	8	10	14	108.2	30.8
PCs - portable	6	7	9	11	14	21.9	27.3
PCs - desktop	127	118	127	142	162	- 0.1	13.0
PC printers	44	49	55	65	71	11.8	14.2
Computer hardware	**207**	**236**	**259**	**282**	**312**	**11.9**	**9.8**
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	23	27	30	32	34	13.6	6.9
Other office equipment	9	8	10	11	13	4.3	16.6
Office equipment	**32**	**36**	**39**	**44**	**47**	**11.1**	**9.4**
LAN hardware	4	5	6	7	9	28.2	17.2
Data communications hardware	**4**	**5**	**6**	**7**	**9**	**28.2**	**17.2**
IT hardware	**243**	**277**	**305**	**333**	**368**	**12.1**	**9.9**
Systems software	11	15	22	28	33	43.9	21.8
Application software	11	15	22	28	33	43.9	21.8
Software products	**22**	**29**	**45**	**55**	**66**	**43.9**	**21.8**
Professional services	54	65	74	83	94	17.1	13.0
Other services	51	57	65	72	79	13.5	9.5
Services	**105**	**122**	**139**	**156**	**173**	**15.4**	**11.4**
Total IT market	**369**	**428**	**489**	**544**	**607**	**15.1**	**11.5**

Poland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	8	2	4	7	11	- 23.8	58.1
Medium	3	16	17	16	17	130.2	1.1
Small	17	21	22	22	22	11.9	0.4
Workstations	2	6	9	13	17	119.8	37.7
PCs - portable	3	7	10	14	16	67.9	30.4
PCs - desktop	102	161	174	203	219	30.5	12.4
PC printers	50	69	81	95	107	28.0	14.4
Computer hardware	**185**	**282**	**317**	**370**	**410**	**30.8**	**13.7**
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	38	43	47	52	57	11.6	9.4
Other office equipment	9	32	34	37	41	89.6	9.3
Office equipment	**48**	**75**	**81**	**89**	**97**	**30.8**	**9.3**
LAN hardware	7	14	15	18	20	48.1	17.5
Data communications hardware	**7**	**14**	**15**	**18**	**20**	**48.1**	**17.5**
IT hardware	**239**	**371**	**413**	**477**	**527**	**31.3**	**13.0**
Systems software	15	20	32	40	46	43.4	20.8
Application software	12	15	24	30	35	43.4	20.8
Software products	**27**	**35**	**55**	**69**	**81**	**43.4**	**20.8**
Professional services	49	58	66	75	86	15.9	14.1
Other services	45	50	60	65	72	15.0	9.2
Services	**95**	**108**	**126**	**141**	**158**	**15.5**	**11.8**
Total IT market	**361**	**513**	**595**	**687**	**766**	**28.3**	**13.5**

Table 30
Poland
ICT Market Value
(Million ECUs)

Table 31
Former Soviet Union
ICT Market Value
(Million ECUs)

Former Soviet Union	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	51	6	24	37	127	- 30.9	128.9
Medium	70	10	13	18	29	- 57.7	52.7
Small	87	10	18	23	34	- 55.0	38.3
Workstations	5	6	22	30	40	103.2	33.9
PCs - portable	6	4	8	14	24	12.8	74.0
PCs - desktop	306	195	296	403	562	- 1.6	37.6
PC printers	65	58	92	123	177	18.9	38.4
Computer hardware	**592**	**290**	**474**	**648**	**993**	**- 10.5**	**44.8**
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	47	50	66	75	87	18.3	14.4
Other office equipment	24	23	35	45	58	21.0	29.1
Office equipment	**71**	**73**	**101**	**120**	**144**	**19.2**	**19.6**
LAN hardware	5	8	15	35	50	66.4	83.2
Data communications hardware	**5**	**8**	**15**	**35**	**50**	**66.4**	**83.2**
IT hardware	**668**	**371**	**589**	**803**	**1,187**	**- 6.1**	**41.9**
Systems software	83	35	51	85	120	- 21.8	53.7
Application software	194	81	119	199	280	- 21.8	53.7
Software products	**277**	**116**	**169**	**285**	**400**	**- 21.8**	**53.7**
Professional services	189	154	200	293	331	2.8	28.6
Other services	232	262	285	331	366	10.9	13.3
Services	**421**	**416**	**485**	**624**	**697**	**7.3**	**19.9**
Total IT market	**1,367**	**902**	**1,244**	**1,712**	**2,285**	**- 4.6**	**35.5**

EU	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	6,604	6,080	4,992	4,402	4,067	- 13.1	- 9.7
Medium	5,274	4,755	4,162	3,888	3,716	- 11.2	- 5.5
Small	4,926	4,839	4,967	5,212	5,437	0.4	4.6
Workstations	1,672	1,732	1,918	2,186	2,527	7.1	14.8
PCs - portable	2,126	2,529	2,727	2,927	3,196	13.3	8.3
PCs - desktop	11,951	11,168	11,180	11,831	12,519	- 3.3	5.8
PC printers	4,141	4,039	3,930	3,949	3,945	- 2.6	0.2
Computer hardware	**36,694**	**35,143**	**33,875**	**34,395**	**35,408**	**- 3.9**	**2.2**
Typewriters	868	784	672	565	499	- 12.0	- 13.9
Calculators	656	682	632	606	586	- 1.9	- 3.7
Copiers	3,768	3,957	3,906	3,957	4,073	1.8	2.1
Other office equipment	2,395	2,877	2,683	2,700	2,760	5.8	1.4
Office equipment	**7,687**	**8,299**	**7,893**	**7,829**	**7,918**	**1.3**	**0.2**
LAN hardware	1,020	1,378	1,667	1,822	1,920	27.8	7.3
Other data communications	1,201	1,282	1,356	1,395	1,368	6.3	0.4
Data communications hardware	**2,221**	**2,660**	**3,023**	**3,217**	**3,288**	**16.7**	**4.3**
IT hardware	**46,602**	**46,102**	**44,791**	**45,441**	**46,614**	**- 2.0**	**2.0**
Systems software	8,611	9,223	9,750	10,293	10,956	6.4	6.0
Application software	6,061	6,765	7,310	7,921	8,652	9.8	8.8
Software products	**14,672**	**15,988**	**17,060**	**18,214**	**19,608**	**7.8**	**7.2**
Professional services	18,923	20,498	21,762	23,056	24,237	7.2	5.5
Processing services	6,661	6,956	7,204	7,415	7,644	4.0	3.0
Network services	1,006	1,162	1,313	1,479	1,677	14.2	13.0
Hardware maintenance & support services	11,146	11,363	11,470	11,609	11,859	1.4	1.7
Services	**37,737**	**39,979**	**41,749**	**43,558**	**45,417**	**5.2**	**4.3**
Total IT market	**99,011**	**102,069**	**103,601**	**107,214**	**111,639**	**2.3**	**3.8**
Service providing equipment	18,166	16,930	15,482	14,535	14,106	- 7.7	- 4.5
Customer premises equipment	8,941	9,118	9,276	9,431	9,540	1.9	1.4
Data network services	10,457	12,154	13,493	14,848	15,836	13.6	8.3
Voice network services	66,886	73,835	80,823	88,036	95,523	9.9	8.7
Installation & maintenance	2,766	2,884	3,005	3,119	3,205	4.2	3.3
Total telecom	**107,216**	**114,920**	**122,079**	**129,971**	**138,211**	**6.7**	**6.4**
Total ICT	**206,227**	**216,989**	**225,680**	**237,184**	**249,850**	**4.6**	**5.2**

Table 32
EU
ICT Market Value
(Million ECUs)

Table 33
EFTA
ICT Market Value
(Million ECUs)

EFTA	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	866	629	704	604	509	- 9.9	- 15.0
Medium	687	549	554	499	464	- 10.2	- 8.5
Small	678	582	745	788	813	4.8	4.4
Workstations	320	299	319	350	386	- 0.2	10.0
PCs - portable	504	474	489	508	567	- 1.5	7.7
PCs - desktop	2,094	1,970	1,763	1,765	1,888	- 8.2	3.5
PC printers	640	615	603	617	622	- 2.9	1.6
Computer hardware	**5,789**	**5,118**	**5,176**	**5,130**	**5,249**	**- 5.4**	**0.7**
Typewriters	86	75	70	62	59	- 9.6	- 7.8
Calculators	83	78	77	74	72	- 3.4	- 3.5
Copiers	407	424	426	439	454	2.4	3.2
Other office equipment	292	315	300	304	310	1.3	1.6
Office equipment	**868**	**893**	**874**	**880**	**895**	**0.3**	**1.2**
LAN hardware	222	288	351	381	399	25.7	6.6
Other data communications	205	225	243	248	246	8.7	0.8
Data communications hardware	**428**	**513**	**593**	**629**	**645**	**17.8**	**4.3**
IT hardware	**7,084**	**6,524**	**6,643**	**6,638**	**6,789**	**- 3.2**	**1.1**
Systems software	1,319	1,400	1,512	1,635	1,765	7.1	8.0
Application software	1,189	1,285	1,412	1,565	1,728	9.0	10.6
Software products	**2,508**	**2,685**	**2,925**	**3,200**	**3,493**	**8.0**	**9.3**
Professional services	3,599	3,673	4,005	4,356	4,644	5.5	7.7
Processing services	1,526	1,579	1,656	1,743	1,797	4.2	4.2
Network services	266	289	330	365	406	11.4	10.8
Hardware maintenance & support services	1,626	1,642	1,619	1,604	1,602	- 0.2	- 0.5
Services	**7,018**	**7,183**	**7,610**	**8,068**	**8,449**	**4.1**	**5.4**
Total IT market	**16,610**	**16,392**	**17,177**	**17,907**	**18,731**	**1.7**	**4.4**
Service providing equipment	3,069	2,880	2,707	2,555	2,405	- 6.1	- 5.8
Customer premises equipment	1,603	1,643	1,661	1,670	1,750	1.8	2.6
Data network services	898	1,071	1,213	1,337	1,443	16.2	9.1
Voice network services	10,786	11,862	12,882	13,937	14,954	9.3	7.7
Installation & maintenance	445	457	469	481	488	2.7	2.0
Total telecom	**16,802**	**17,913**	**18,933**	**19,979**	**21,039**	**6.2**	**5.4**
Total ICT	**33,411**	**34,305**	**36,110**	**37,886**	**39,770**	**4.0**	**4.9**

EU & EFTA	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	7,470	6,709	5,696	5,005	4,576	- 12.7	- 10.4
Medium	5,961	5,304	4,716	4,387	4,179	- 11.1	- 5.9
Small	5,604	5,421	5,712	6,001	6,250	1.0	4.6
Workstations	1,992	2,031	2,237	2,535	2,913	6.0	14.1
PCs - portable	2,630	3,003	3,216	3,435	3,763	10.6	8.2
PCs - desktop	14,045	13,138	12,943	13,596	14,407	- 4.0	5.5
PC printers	4,781	4,655	4,533	4,566	4,567	- 2.6	0.4
Computer hardware	**42,483**	**40,260**	**39,052**	**39,525**	**40,657**	**- 4.1**	**2.0**
Typewriters	954	859	742	628	558	- 11.8	- 13.3
Calculators	739	760	709	680	658	- 2.0	- 3.7
Copiers	4,175	4,381	4,332	4,396	4,527	1.9	2.2
Other office equipment	2,688	3,192	2,983	3,004	3,070	5.3	1.5
Office equipment	**8,555**	**9,192**	**8,766**	**8,708**	**8,813**	**1.2**	**0.3**
LAN hardware	1,242	1,666	2,017	2,203	2,319	27.4	7.2
Other data communications	1,406	1,507	1,599	1,643	1,614	6.6	0.5
Data communications hardware	**2,648**	**3,173**	**3,616**	**3,846**	**3,933**	**16.9**	**4.3**
IT hardware	**53,686**	**52,625**	**51,434**	**52,080**	**53,403**	**- 2.1**	**1.9**
Systems software	9,929	10,623	11,262	11,928	12,721	6.5	6.3
Application software	7,250	8,050	8,723	9,487	10,380	9.7	9.1
Software products	**17,180**	**18,674**	**19,985**	**21,415**	**23,101**	**7.9**	**7.5**
Professional services	22,523	24,171	25,766	27,413	28,881	7.0	5.9
Processing services	8,187	8,535	8,860	9,157	9,441	4.0	3.2
Network services	1,273	1,450	1,643	1,844	2,083	13.6	12.6
Hardware maintenance & support services	12,772	13,005	13,089	13,213	13,460	1.2	1.4
Services	**44,755**	**47,162**	**49,359**	**51,626**	**53,866**	**5.0**	**4.5**
Total IT market	**115,621**	**118,461**	**120,778**	**125,120**	**130,370**	**2.2**	**3.9**
Service providing equipment	21,235	19,810	18,190	17,090	16,510	- 7.4	- 4.7
Customer premises equipment	10,545	10,761	10,937	11,101	11,290	1.8	1.6
Data network services	11,356	13,224	14,706	16,185	17,279	13.8	8.4
Voice network services	77,672	85,697	93,705	101,973	110,477	9.8	8.6
Installation & maintenance	3,211	3,341	3,474	3,601	3,693	4.0	3.1
Total telecom	**124,018**	**132,833**	**141,012**	**149,950**	**159,249**	**6.6**	**6.3**
Total ICT	**239,638**	**251,294**	**261,790**	**275,070**	**289,620**	**4.5**	**5.2**

Table 34
EU & EFTA
ICT Market Value
(Million ECUs)

Table 35
Eastern Europe
ICT Market Value
(Million ECUs)

Eastern Europe	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	71	30	54	78	178	- 12.5	81.3
Medium	94	80	89	83	94	- 2.6	2.7
Small	139	88	103	115	136	- 13.6	14.7
Workstations	13	33	55	71	91	106.2	28.9
PCs - portable	19	27	36	52	73	37.5	41.6
PCs - desktop	621	642	751	922	1,150	10.0	23.8
PC printers	204	257	313	381	468	24.0	22.3
Computer hardware	**1,160**	**1,157**	**1,402**	**1,701**	**2,190**	**9.9**	**25.0**
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	133	153	182	201	226	16.8	11.5
Other office equipment	54	84	102	120	144	37.7	18.5
Office equipment	**187**	**237**	**284**	**321**	**370**	**23.2**	**14.1**
LAN hardware	20	32	42	66	87	46.0	44.5
Data communications hardware	**20**	**32**	**42**	**66**	**87**	**46.0**	**44.5**
IT hardware	**1,367**	**1,426**	**1,728**	**2,088**	**2,647**	**12.4**	**23.8**
Systems software	128	105	147	202	257	7.2	32.1
Application software	232	141	201	299	397	- 7.0	40.6
Software products	**360**	**246**	**348**	**501**	**654**	**- 1.7**	**37.1**
Professional services	337	332	410	532	606	10.3	21.5
Other services	375	427	479	547	608	13.1	12.7
Services	**712**	**758**	**889**	**1,080**	**1,214**	**11.8**	**16.8**
Total IT market	**2,439**	**2,430**	**2,965**	**3,668**	**4,515**	**10.3**	**23.4**

Austria	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	21	25	17	15	14	- 10.0	- 9.3
Medium	379	400	318	304	317	- 8.4	- 0.2
Small	4,635	3,300	4,699	5,158	5,538	0.7	8.6
Workstations	2,900	3,684	4,629	5,781	7,285	26.3	25.5
PCs - portable	17,402	24,379	33,058	39,802	47,205	37.8	19.5
PCs - desktop	134,867	156,994	162,313	172,417	199,562	9.7	10.9
PC printers	152,113	170,450	194,664	214,135	232,304	13.1	9.2
Typewriters	48,662	37,238	35,376	30,706	28,250	- 14.7	- 10.6
Calculators	440,029	417,439	427,040	441,987	468,506	- 1.5	4.7
Copiers	32,880	25,263	26,021	26,021	26,801	- 11.0	1.5
PC NICs	31,900	43,900	56,600	64,500	70,800	33.2	11.8

Table 36
Austria
ICT Hardware
Shipments (Units)

Belgium/Luxembourg	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	42	35	33	29	26	- 11.4	- 11.2
Medium	528	360	404	384	395	- 12.5	- 1.1
Small	5,051	5,000	6,275	6,926	7,475	11.5	9.1
Workstations	3,278	3,937	4,900	6,098	7,826	22.3	26.4
PCs - portable	31,348	43,831	55,227	65,168	74,292	32.7	16.0
PCs - desktop	205,792	209,914	217,478	220,367	218,825	2.8	0.3
PC printers	229,336	256,985	291,097	315,324	337,026	12.7	7.6
Typewriters	80,106	56,022	47,395	43,129	40,714	- 23.1	- 7.3
Calculators	694,350	528,130	537,636	569,895	605,228	- 12.0	6.1
Copiers	52,583	45,030	46,967	48,705	50,068	- 5.5	3.2
PC NICs	64,700	93,700	115,600	125,500	123,400	33.7	3.3

Table 37
Belgium/Luxembourg
ICT Hardware
Shipments (Units)

Denmark	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	37	38	28	24	22	- 13.0	- 11.4
Medium	361	315	285	272	279	- 11.1	- 1.1
Small	2,731	2,500	3,477	3,737	3,871	12.8	5.5
Workstations	2,101	2,244	2,547	2,929	3,427	10.1	16.0
PCs - portable	23,318	32,433	44,758	57,738	66,976	38.5	22.3
PCs - desktop	166,295	189,910	214,840	225,981	235,501	13.7	4.7
PC printers	154,756	173,177	202,845	216,063	225,973	14.5	5.5
Typewriters	41,091	28,239	27,392	24,653	23,174	- 18.4	- 8.0
Calculators	551,836	428,821	442,543	437,233	442,042	- 10.4	- 0.1
Copiers	29,390	28,215	29,344	31,462	34,355	- 0.1	8.2
PC NICs	112,900	143,800	157,900	171,200	180,800	18.3	7.0

Table 38
Denmark
ICT Hardware
Shipments (Units)

Table 39
Finland
ICT Hardware
Shipments (Units)

Finland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	19	12	14	13	11	- 14.2	- 11.4
Medium	167	145	133	124	128	- 10.8	- 1.9
Small	2,492	2,100	3,008	3,184	3,325	9.9	5.1
Workstations	2,251	1,910	2,081	2,317	2,578	- 3.9	11.3
PCs - portable	16,726	18,739	26,422	35,141	47,089	25.7	33.5
PCs - desktop	126,560	131,309	123,455	149,523	174,333	- 1.2	18.8
PC printers	84,193	102,323	111,898	126,562	145,419	15.3	14.0
Typewriters	31,929	21,460	18,713	15,869	15,075	- 23.4	- 10.2
Calculators	388,968	314,085	317,226	320,398	323,602	- 9.7	1.0
Copiers	32,681	31,969	32,313	32,608	33,586	- 0.6	2.0
PC NICs	78,500	87,300	106,600	116,100	128,800	16.5	9.9

Table 40
France
ICT Hardware
Shipments (Units)

France	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	182	156	134	116	104	- 14.2	- 11.9
Medium	2,750	2,100	1,981	1,921	2,033	- 15.1	1.3
Small	27,900	27,000	26,032	27,312	28,833	- 3.4	5.2
Workstations	23,062	27,224	32,955	39,588	47,952	19.5	20.6
PCs - portable	145,100	195,180	241,828	290,194	333,723	29.1	17.5
PCs - desktop	1,149,776	1,208,814	1,340,806	1,483,195	1,639,911	8.0	10.6
PC printers	1,004,965	1,140,968	1,284,878	1,414,839	1,541,571	13.1	9.5
Typewriters	397,863	279,142	252,902	212,691	195,676	- 20.3	- 12.0
Calculators	3,877,853	3,213,415	3,081,665	3,312,789	3,528,121	- 10.9	7.0
Copiers	305,563	259,409	260,706	265,920	273,897	- 7.6	2.5
PC NICs	398,900	510,200	591,600	638,900	678,800	21.8	7.1

Table 41
Germany
ICT Hardware
Shipments (Units)

Germany	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	392	329	238	215	200	- 22.1	- 8.3
Medium	4,240	3,700	3,103	2,955	2,968	- 14.5	- 2.2
Small	33,400	40,500	41,970	45,602	49,124	12.1	8.2
Workstations	35,952	42,563	52,125	64,851	82,622	20.4	25.9
PCs - portable	236,575	343,985	433,421	491,933	548,013	35.4	12.4
PCs - desktop	2,123,558	2,352,420	2,449,205	2,764,216	3,113,365	7.4	12.7
PC printers	1,901,084	2,160,972	2,406,662	2,558,134	2,727,920	12.5	6.5
Typewriters	1,357,283	1,179,664	1,198,539	1,102,656	981,364	- 6.0	- 9.5
Calculators	11,772,945	10,266,560	10,625,890	10,647,141	10,434,199	- 5.0	- 0.9
Copiers	685,689	602,149	596,128	578,244	601,374	- 6.8	0.4
PC NICs	461,800	706,100	863,700	942,700	1,006,000	36.8	7.9

Greece	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	3	3	3	3	4	0.0	15.5
Medium	50	61	62	76	97	11.4	25.1
Small	709	852	926	1,109	1,341	14.3	20.3
Workstations	674	837	1,265	1,704	2,568	37.0	42.5
PCs - portable	4,767	5,796	7,315	9,404	10,633	23.9	20.6
PCs - desktop	45,497	53,707	63,819	71,810	82,192	18.4	13.5
PC printers	7,374	10,976	16,789	23,108	32,543	50.9	39.2
Typewriters	88,872	117,076	129,410	153,399	166,160	20.7	13.3
Calculators	60,468	81,205	92,809	114,506	115,996	23.9	11.8
Copiers	32,052	23,415	21,265	18,603	16,242	- 18.5	- 12.6
PC NICs	59,686	56,146	56,761	57,579	58,969	- 2.5	1.9

Table 42
Greece
ICT Hardware
Shipments (Units)

Ireland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	5	7	6	6	7	9.5	8.0
Medium	173	201	192	208	241	5.3	12.0
Small	2,574	2,963	2,962	3,140	3,394	7.3	7.0
Workstations	1,825	2,256	2,481	2,781	3,095	16.6	11.7
PCs - portable	4,580	5,571	7,113	7,743	8,485	24.6	9.2
PCs - desktop	51,013	53,773	50,909	49,541	50,909	- 0.1	0.0
PC printers	20,725	26,926	32,726	36,829	41,974	25.7	13.3
Typewriters	56,400	46,156	45,730	40,738	32,620	- 10.0	- 15.5
Calculators	470,276	405,014	411,936	425,515	450,395	- 6.4	4.6
Copiers	37,706	31,523	31,426	30,242	29,202	- 8.7	- 3.6
PC NICs	12,714	17,738	21,630	23,005	23,931	30.4	5.2

Table 43
Ireland
ICT Hardware
Shipments (Units)

Italy	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	142	93	105	90	81	- 14.0	- 12.2
Medium	2,600	1,395	1,316	1,382	1,386	- 28.9	2.6
Small	22,900	22,200	24,237	25,073	26,545	2.9	4.7
Workstations	9,804	11,480	13,610	16,258	19,574	17.8	19.9
PCs - portable	88,060	142,010	167,572	196,897	240,214	37.9	19.7
PCs - desktop	769,785	764,570	811,818	850,845	882,212	2.7	4.2
PC printers	677,993	720,343	727,705	737,001	745,889	3.6	1.2
Typewriters	279,620	224,330	195,612	174,095	160,167	- 16.4	- 9.5
Calculators	2,370,800	2,396,000	2,442,900	2,485,779	2,526,002	1.5	1.7
Copiers	192,580	184,120	173,793	162,626	158,654	- 5.0	- 4.5
PC NICs	136,300	202,000	245,900	268,200	279,300	34.3	6.6

Table 44
Italy
ICT Hardware
Shipments (Units)

Table 45
Netherlands
ICT Hardware
Shipments (Units)

Netherlands	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	67	46	47	40	35	- 16.2	- 13.7
Medium	930	650	795	792	848	- 7.5	3.3
Small	6,500	7,800	6,870	7,072	7,176	2.8	2.2
Workstations	6,948	7,708	9,523	11,317	12,933	17.1	16.5
PCs - portable	43,951	58,537	81,952	101,620	121,944	36.6	22.0
PCs - desktop	469,282	462,925	476,525	490,063	501,123	0.8	2.5
PC printers	368,465	403,103	448,049	477,933	501,058	10.3	5.8
Typewriters	164,089	127,431	115,006	96,950	92,006	- 16.3	- 10.6
Calculators	1,403,727	1,149,593	1,161,089	1,172,700	1,184,427	- 9.1	1.0
Copiers	132,885	106,250	111,031	115,250	117,555	- 8.6	2.9
PC NICs	145,900	189,600	229,900	247,800	251,400	25.5	4.6

Table 46
Norway
ICT Hardware
Shipments (Units)

Norway	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	20	12	16	14	12	- 10.6	- 13.4
Medium	202	215	166	157	166	- 9.3	0.0
Small	2,402	2,300	2,610	2,940	3,310	4.2	12.6
Workstations	3,122	3,430	3,926	4,607	5,530	12.1	18.7
PCs - portable	27,715	32,653	39,184	46,237	55,022	18.9	18.5
PCs - desktop	160,357	168,159	166,415	173,302	176,555	1.9	3.0
PC printers	107,081	124,520	139,565	146,003	153,389	14.2	4.8
Typewriters	33,733	25,086	24,584	22,617	22,165	- 14.6	- 5.0
Calculators	464,039	370,016	363,356	354,635	343,287	- 11.5	- 2.8
Copiers	26,882	22,344	22,947	23,796	24,748	- 7.6	3.8
PC NICs	78,300	111,400	138,100	151,600	160,500	32.8	7.8

Table 47
Portugal
ICT Hardware
Shipments (Units)

Portugal	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	21	31	29	36	46	17.5	25.9
Medium	185	242	263	334	446	19.2	30.2
Small	2,282	2,989	3,392	4,238	5,228	21.9	24.1
Workstations	1,035	1,459	1,917	2,471	3,508	36.1	35.3
PCs - portable	3,035	3,854	5,027	5,966	7,568	28.7	22.7
PCs - desktop	35,178	37,508	41,481	38,849	51,376	8.6	11.3
PC printers	5,876	8,884	13,589	18,712	95,573	52.1	165.2
Typewriters	99,767	120,984	136,405	165,685	40,438	16.9	- 45.6
Calculators	70,052	86,711	103,065	121,509	387,377	21.3	93.9
Copiers	35,174	25,702	24,276	21,260	27,038	- 16.9	5.5
PC NICs	121,967	109,740	112,103	115,819	29,127	- 4.1	- 49.0

Spain	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	63	43	54	48	43	- 7.4	- 10.8
Medium	777	570	677	687	721	- 6.7	3.2
Small	13,163	13,000	14,856	1,604	17,712	6.2	9.2
Workstations	4,124	6,044	8,015	10,659	15,240	39.4	37.9
PCs - portable	56,820	80,815	87,280	98,103	115,663	23.9	15.1
PCs - desktop	547,389	525,620	553,412	586,923	625,097	0.5	6.3
PC printers	470,696	529,379	547,012	553,775	558,583	7.8	1.1
Typewriters	192,103	147,050	132,345	115,140	94,415	- 17.0	- 15.5
Calculators	1,559,780	1,344,593	1,411,823	1,468,296	1,515,282	- 4.9	3.6
Copiers	137,199	113,654	112,517	110,717	112,931	- 9.4	0.2
PC NICs	126,800	152,000	186,500	207,500	224,900	21.3	9.8

Table 48
Spain
ICT Hardware
Shipments (Units)

Sweden	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	41	33	30	27	25	- 14.5	- 8.7
Medium	544	515	437	414	424	- 10.4	- 1.5
Small	4,100	4,200	4,638	5,025	5,309	6.4	7.0
Workstations	7,042	7,307	8,256	9,423	11,015	8.3	15.5
PCs - portable	45,833	55,222	69,856	79,636	89,192	23.5	13.0
PCs - desktop	248,543	264,117	270,781	286,997	300,037	4.4	5.3
PC printers	179,742	217,260	244,777	261,007	277,277	16.7	6.4
Typewriters	144,289	110,449	99,404	86,482	70,915	- 17.0	- 15.5
Calculators	1,512,987	1,344,593	1,383,587	1,409,564	1,454,670	- 4.4	2.5
Copiers	94,667	78,421	77,637	76,395	77,923	- 9.4	0.2
PC NICs	181,100	207,300	247,300	264,100	278,900	16.9	6.2

Table 49
Sweden
ICT Hardware
Shipments (Units)

Switzerland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	51	51	43	38	34	- 8.2	- 11.1
Medium	622	415	497	467	482	- 10.6	- 1.5
Small	5,126	5,700	6,498	7,050	7,551	12.6	7.8
Workstations	7,763	8,214	9,667	11,378	13,975	11.6	20.2
PCs - portable	60,295	72,544	87,778	100,067	116,078	20.7	15.0
PCs - desktop	275,726	281,558	305,530	310,374	315,947	5.3	1.7
PC printers	231,891	282,105	340,605	394,220	440,906	21.2	13.8
Typewriters	104,507	74,192	68,850	62,516	60,015	- 18.8	- 6.6
Calculators	936,036	735,488	739,901	748,780	766,001	- 11.1	1.7
Copiers	67,764	57,889	58,468	60,923	63,360	- 7.1	4.1
PC NICs	100,300	122,000	155,000	167,800	176,400	24.3	6.7

Table 50
Switzerland
ICT Hardware
Shipments (Units)

Table 51
United Kingdom
ICT Hardware
Shipments (Units)

United Kingdom	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	191	186	141	121	108	- 14.1	- 12.5
Medium	2,520	2,100	2,050	2,070	2,080	- 9.8	0.7
Small	26,100	27,500	27,413	29,307	30,848	2.5	6.1
Workstations	25,401	27,901	33,402	41,839	53,693	14.7	26.8
PCs - portable	217,972	278,495	401,033	485,250	606,563	35.6	23.0
PCs - desktop	1,301,878	1,690,556	1,734,248	1,827,966	1,882,744	15.4	4.2
PC printers	1,158,576	1,330,299	1,492,809	1,642,303	1,771,470	13.5	8.9
Typewriters	463,574	327,050	313,968	269,070	247,545	- 17.7	- 11.2
Calculators	4,125,567	3,410,671	3,594,847	3,602,037	3,648,863	- 6.7	0.7
Copiers	334,582	277,274	283,928	292,446	305,606	- 7.9	3.7
PC NICs	530,200	823,200	989,000	1,037,900	1,049,200	36.6	3.0

Table 52
Czech & Slovak
Republics
ICT Hardware
Shipments (Units)

Czech & Slovak Republics	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	4	7	10	13	16	58.1	26.5
Medium	41	78	90	102	108	48.2	9.5
Small	660	1,690	1,900	2,200	2,500	69.7	14.7
PCs/Workstations	96,345	161,178	152,840	176,050	213,300	26.0	18.1
PC printers	86,726	156,402	157,039	179,340	208,242	34.6	15.2
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	13,500	17,800	20,900	22,300	24,000	24.4	7.2
PC NICs	38,400	56,200	60,800	70,000	84,800	25.8	18.1

Table 53
Hungary
ICT Hardware
Shipments (Units)

Hungary	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	3	3	3	4	4	0.0	15.5
Medium	55	100	110	102	98	41.4	- 5.6
Small	355	507	610	695	780	31.1	13.1
PCs/Workstations	70,696	99,275	115,540	132,715	158,965	27.8	17.3
PC printers	63,000	76,826	91,075	109,117	120,484	20.2	15.0
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	10,100	12,000	13,000	14,500	16,000	13.5	10.9
PC NICs	42,000	59,280	69,000	79,200	94,800	28.2	17.2

Poland	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	3	1	2	4	5	- 18.4	58.1
Medium	14	63	68	72	78	120.4	7.1
Small	403	643	690	760	850	30.8	11.0
PCs/Workstations	95,507	178,400	192,570	230,845	266,100	42.0	17.6
PC printers	99,470	162,018	195,382	218,049	236,256	40.2	10.0
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	21,000	23,500	25,000	26,750	28,650	9.1	7.1
PC NICs	35,000	71,220	76,800	92,000	106,000	48.1	17.5

Table 54
Poland
ICT Hardware
Shipments (Units)

Former Soviet Union	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	60	5	15	25	75	- 50.0	123.6
Medium	235	35	50	75	125	- 53.9	58.1
Small	10,800	300	700	1,200	2,000	- 74.5	69.0
PCs/Workstations	259,361	210,820	311,450	451,950	652,600	9.6	44.8
PC printers	212,200	185,000	300,000	400,000	575,000	18.9	38.4
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	24,000	24,100	25,500	33,700	38,500	3.1	22.9
PC NICs	28,000	42,000	77,500	180,000	260,000	66.4	83.2

Table 55
Former Soviet Union
ICT Hardware
Shipments (Units)

EU	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	1,145	967	818	728	676	- 15.5	- 9.1
Medium	15,114	11,694	11,128	11,081	11,494	- 14.2	1.6
Small	143,310	152,304	158,410	155,120	181,547	5.1	7.1
Workstations	114,204	133,653	162,739	200,495	252,438	19.4	24.5
PCs - portable	855,527	1,190,506	1,532,526	1,810,016	2,134,074	33.8	18.0
PCs - desktop	6,865,443	7,549,717	7,954,542	8,609,756	9,283,255	7.6	8.0
PC printers	5,999,845	6,762,012	7,464,161	7,994,020	8,579,579	11.5	7.2
Typewriters	3,220,767	2,653,143	2,594,704	2,398,206	2,074,277	- 10.2	- 10.6
Calculators	26,957,654	23,310,713	23,906,204	24,357,401	24,837,931	- 5.8	1.9
Copiers	1,975,402	1,696,741	1,691,380	1,675,474	1,726,923	- 7.5	1.0
PC NICs	2,171,867	3,004,224	3,570,594	3,836,103	3,905,827	28.2	4.6

Table 56
EU
ICT Hardware
Shipments (Units)

Table 57
EFTA
ICT Hardware
Shipments (Units)

EFTA	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	152	133	120	107	96	- 11.1	- 10.6
Medium	1,914	1,690	1,551	1,466	1,517	- 10.0	- 1.1
Small	18,755	17,600	21,453	23,357	25,033	7.0	8.0
Workstations	24,813	24,161	28,629	32,883	38,636	7.4	16.2
PCs - portable	167,971	203,537	256,298	300,883	354,586	23.5	17.6
PCs - desktop	828,588	869,522	899,239	959,998	1,014,077	4.2	6.2
PC printers	755,019	896,659	1,031,511	1,141,926	1,249,295	16.9	10.1
Typewriters	363,120	268,424	246,927	218,189	196,420	- 17.5	- 10.8
Calculators	3,742,059	3,181,622	3,231,109	3,275,364	3,356,067	- 7.1	1.9
Copiers	254,874	215,885	217,385	219,743	226,418	- 7.6	2.1
PC NICs	470,100	571,900	703,600	764,100	815,400	22.3	7.7

Table 58
EU & EFTA
ICT Hardware
Shipments (Units)

EU & EFTA	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	1,297	1,100	938	835	772	- 15.0	- 9.3
Medium	17,028	13,384	12,679	12,547	13,011	- 13.7	1.3
Small	162,065	169,904	179,863	178,477	206,580	5.3	7.2
Workstations	139,017	157,814	191,368	233,378	291,074	17.3	23.3
PCs - portable	1,023,498	1,394,043	1,788,824	2,110,899	2,488,660	32.2	18.0
PCs - desktop	7,694,031	8,419,239	8,853,781	9,569,754	10,297,332	7.3	7.8
PC printers	6,754,864	7,658,670	8,495,671	9,135,946	9,828,874	12.1	7.6
Typewriters	3,583,887	2,921,567	2,841,631	2,616,395	2,270,697	- 11.0	- 10.6
Calculators	30,699,713	26,492,335	27,137,313	27,632,764	28,193,998	- 6.0	1.9
Copiers	2,230,276	1,912,626	1,908,765	1,895,217	1,953,342	- 7.5	1.2
PC NICs	2,641,967	3,576,124	4,274,194	4,600,203	4,721,227	27.2	5.1

Table 59
Eastern Europe
ICT Hardware
Shipments (Units)

Eastern Europe	1991	1992	1993	1994	1995	CAGR 91-93 %	CAGR 93-95 %
Large	70	16	30	46	100	- 34.5	82.6
Medium	345	276	318	351	409	- 4.0	13.4
Small	12,218	3,140	3,900	4,855	6,130	- 43.5	25.4
PCs/Workstations	521,909	649,673	772,400	991,560	1,290,965	21.7	29.3
PC printers	461,396	580,246	743,496	906,506	1,139,982	26.9	23.8
Typewriters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calculators	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copiers	68,600	77,400	84,400	97,250	107,150	10.9	12.7
PC NICs	143,400	228,700	284,100	421,200	545,600	40.8	38.6

8. ICT Trade Flows

The data presented on trade are based upon the Combined Nomenclature, an international standard for such data. The details concerning the product categories included is given at the end of the statistical section. In general terms, the trade data can be considered to match well but not exactly with the classification used for IT and telecommunications hardware throughout the statistical section. Data processing equipment, electronic office equipment and components and related spares are all included. Semiconductor devices and other electronic components are not included.

Figures are presented in current ECU, according to standard valuation rules. Imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting member state (fob). Data availability for this exercise has been governed by the framework of the European Commission's statistical systems. Due to changes made in the past twelve months, this has allowed the coverage of historical data to be expanded to include the US, Japan and major EFTA states, but at the time of writing insufficient data were available concerning 1993 to provide meaningful data.

The term intra-EU refers to trade between member states. Extra-EU trade is that between a member state and a non-member state. It should be noted that intra-EU import statistics are based upon the country of consignment, and not necessarily on the country of origin.

A cursory examination of the data confirms the notion that Europe runs a trade deficit in IT and telecommunications products. Further examination of the data reveals that the situation appears to be worsening in spite of sluggish market demand. In 1989, the ICT trade deficit of EU countries amounted to ECU 13 billion. By 1992 this figure had risen to nearly ECU 19 billion. The EFTA nations also run a sizeable ICT trade deficit, but this has actually shrunk slightly since 1989. Together the EU and EFTA nations returned a ECU 22 billion deficit on ICT products (excluding semiconductor devices) in 1992.

By contrast, the US and Japan both achieve a trade surplus in these products. In the case of Japan, the size of this surplus reached an impressive ECU 24 billion in 1992, up from ECU 18 billion in 1989. The US trade surplus of ECU 6 billion in 1992 appears modest in comparison, particularly when it is remembered that the equivalent figure for 1989 was ECU 10 billion.

The one-sided nature of trade in ICT products is emphasised by comparing the volume of exports from Japan and the US to EU states with the volume of trade flowing in the reverse direction. To illustrate, in 1992 the USA and Japan exported goods of roughly equal value to EU States; ECU 10.9 billion and ECU 9.2 billion respectively. Imports to Japan from the EU amounted to only ECU 0.5 billion; imports to the USA from the EU were somewhat higher at ECU 2.9 billion.

Whilst the overall position of Europe with respect to trade in ICT products is weak, the Republic of Ireland can draw some comfort from their current position. In 1992 Ireland recorded an overall ICT trade surplus of ECU 2.0 billion and managed to turn a deficit with respect to non-EU countries only into a surplus of ECU 0.2 billion.

Table 60
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

Production	1991	1992	1991 % breakdown	1992 % breakdown
Austria	3,703	4,159	1.8	1.9
Belgium/Luxembourg	5,438	5,724	2.6	2.6
Denmark	4,271	4,357	2.1	2.0
Finland	2,818	3,039	1.4	1.4
France	37,353	39,246	18.0	17.8
Germany	48,238	52,344	23.2	23.7
Greece	1,112	1,234	0.5	0.6
Ireland	3,267	3,815	1.6	1.7
Italy	25,669	27,481	12.4	12.5
Netherlands	8,697	9,116	4.2	4.1
Norway	3,759	3,808	1.8	1.7
Portugal	723	932	0.3	0.4
Spain	10,710	11,758	5.2	5.3
Sweden	9,967	10,044	4.8	4.6
Switzerland	7,321	7,928	3.5	3.6
United Kingdom	34,579	35,738	16.7	16.2

Table 61
Austria
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1990	1991	1992
Imports from EU	693,261	734,470	671,435
Imports from Other Countries	853,121	1,058,411	1,002,421
Imports Total	1,546,382	1,792,881	1,673,856
Exports to EU	339,251	406,049	371,883
Exports to Other Countries	249,062	339,106	331,435
Exports Total	588,313	745,155	703,319
Exports to EU/Total Exports	57.7%	54.5%	52.9%
Imports from EU/Total Imports	44.8%	41.0%	40.1%
Trade Balance	- 958,069	- 1,047,726	- 970,538
EU Trade Balance	- 354,010	- 328,421	- 299,552

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	2,024,207	1,725,801	1,723,582	1,723,633
Imports Extra-EU	1,570,091	613,692	659,101	688,210
Imports Total	3,594,298	2,339,493	2,382,683	2,411,843
Exports Intra-EU	933,820	976,365	977,700	934,668
Exports Extra-EU	364,871	366,707	430,801	482,217
Exports Total	1,298,691	1,343,072	1,408,501	1,416,885
Extra-EU/Intra-EU Exports	39.1%	37.6%	44.1%	51.6%
Extra-EU/Intra-EU Imports	77.6%	35.6%	38.2%	39.9%
Trade Balance	- 2.295,607	- 996,421	- 974,182	- 994,958
Extra EU Trade Balance	- 1,205,220	- 246,985	- 228,300	- 205,993

Table 62
Belgium/Luxembourg
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	747,950	835,377	964,742	985,900
Imports Extra-EU	447,417	449,731	447,411	463,602
Imports Total	1,195,367	1,285,108	1,412,153	1,449,502
Exports Intra-EU	253,891	252,317	227,472	239,785
Exports Extra-EU	184,215	259,083	355,227	350,563
Exports Total	438,106	511,400	582,699	590,348
Extra-EU/Intra-EU Exports	72.6%	102.7%	156.2%	146.2%
Extra-EU/Intra-EU Imports	59.8%	53.8%	46.4%	47.0%
Trade Balance	- 757,261	- 773,708	- 829,454	- 859,154
Extra EU Trade Balance	- 263,202	- 190,648	- 92,184	- 113,039

Table 63
Denmark
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1990	1991	1992
Imports from EU	344,868	240,873	228,017
Imports from Other Countries	702,457	451,269	520,463
Imports Total	1,047,325	692,142	748,480
Exports to EU	195,397	174,529	378,048
Exports to Other Countries	472,003	221,589	272,288
Exports Total	667,400	396,118	650,336
Exports to EU/Total Exports	29.3%	44.1%	58.1%
Imports from EU/Total Imports	32.9%	34.8%	30.5%
Trade Balance	- 379,925	- 296,023	- 98,144
EU Trade Balance	- 149,471	- 66,343	150,031

Table 64
Finland
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

Table 65
France
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	4,987,299	5,200,512	5,346,357	5,383,694
Imports Extra-EU	3,103,016	3,049,531	3,061,844	3,326,950
Imports Total	8,090,315	8,250,043	8,408,201	8,710,644
Exports Intra-EU	3,606,666	3,622,405	4,121,447	4,190,850
Exports Extra-EU	1,909,868	1,868,712	1,983,912	2,213,554
Exports Total	5,516,534	5,491,117	6,105,359	6,404,404
Extra-EU/Intra-EU Exports	53.0%	51.6%	48.1%	52.8%
Extra-EU/Intra-EU Imports	62.2%	58.6%	57.3%	61.8%
Trade Balance	- 2,573,781	- 2,758,926	- 2,302,842	- 2,306,240
Extra EU Trade Balance	- 1,193,148	- 1,180,819	- 1,077,932	- 1,113,396

Table 66
Germany
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	5,275,255	5,700,419	6,720,445	6,839,986
Imports Extra-EU	6,379,184	6,733,870	8,184,650	8,849,618
Imports Total	11,654,439	12,434,289	14,905,095	15,689,604
Exports Intra-EU	5,673,649	5,573,039	5,424,444	5,308,291
Exports Extra-EU	3,278,183	3,402,823	4,241,507	4,308,217
Exports Total	8,951,832	8,975,862	9,665,951	9,616,508
Extra-EU/Intra-EU Exports	57.8%	61.1%	78.2%	81.2%
Extra-EU/Intra-EU Imports	120.9%	118.1%	121.8%	129.4%
Trade Balance	- 2,702,607	- 3,458,427	- 5,239,144	- 6,073,096
Extra EU Trade Balance	- 3,101,001	- 3,331,047	- 3,943,143	- 4,541,401

Table 67
Greece
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	194,699	562,461	225,760	233,161
Imports Extra-EU	127,583	118,756	169,015	155,718
Imports Total	322,282	681,217	394,775	388,879
Exports Intra-EU	11,660	13,616	23,720	26,840
Exports Extra-EU	2,193	2,859	4,781	7,477
Exports Total	13,853	16,475	28,501	34,317
Extra-EU/Intra-EU Exports	18.8%	21.0%	20.2%	27.9%
Extra-EU/Intra-EU Imports	65.5%	21.1%	74.9%	66.8%
Trade Balance	- 308,429	- 664,742	- 366,274	- 354,562
Extra EU Trade Balance	- 125,390	- 115,897	- 164,234	- 148,241

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	652,899	673,305	718,256	820,716
Imports Extra-EU	1,171,162	1,126,690	1,176,317	763,642
Imports Total	1,824,061	1,799,995	1,894,573	1,584,358
Exports Intra-EU	3,142,131	2,894,904	2,493,699	2,544,488
Exports Extra-EU	778,627	848,448	956,408	1,056,435
Exports Total	3,920,758	3,743,352	3,450,107	3,600,923
Extra-EU/Intra-EU Exports	24.8%	29.3%	38.4%	41.5%
Extra-EU/Intra-EU Imports	179.4%	167.3%	163.8%	93.0%
Trade Balance	2,096,697	1,943,357	1,555,534	2,016,565
Extra EU Trade Balance	- 392,535	- 278,242	- 219,909	292,793

Table 68
Ireland
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	2,977,271	3,233,702	3,490,512	3,403,698
Imports Extra-EU	2,102,255	2,000,475	2,174,351	2,095,189
Imports Total	5,079,526	5,234,177	5,664,863	5,498,887
Exports Intra-EU	2,843,377	2,784,080	2,921,220	2,533,377
Exports Extra-EU	1,151,614	1,008,347	856,777	920,367
Exports Total	3,994,991	3,792,427	3,777,997	3,453,744
Extra-EU/Intra-EU Exports	40.5%	36.2%	29.3%	36.3%
Extra-EU/Intra-EU Imports	70.6%	61.9%	62.3%	61.6%
Trade Balance	- 1,084,535	- 1,441,750	- 1,886,866	- 2,045,143
Extra EU Trade Balance	- 950,641	- 992,128	- 1,317,574	- 1,174,822

Table 69
Italy
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	3,479,634	3,888,467	3,848,048	4,004,042
Imports Extra-EU	3,410,361	3,900,262	4,680,573	4,772,542
Imports Total	6,889,995	7,788,729	8,528,621	8,776,584
Exports Intra-EU	4,559,260	5,029,656	4,702,250	4,838,497
Exports Extra-EU	1,292,844	1,330,712	1,306,776	1,446,514
Exports Total	5,852,104	6,360,368	6,009,026	6,285,011
Extra-EU/Intra-EU Exports	28.4%	26.5%	27.8%	29.9%
Extra-EU/Intra-EU Imports	98.0%	100.3%	121.6%	119.2%
Trade Balance	- 1,037,891	- 1,428,361	- 2,519,595	- 2,491,573
Extra EU Trade Balance	- 2,117,517	- 2,569,550	- 3,373,797	- 3,326,028

Table 70
Netherlands
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

Table 71
Norway
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1990	1991	1992
Imports from EU	385,080	369,034	339,378
Imports from Other Countries	546,957	571,259	656,873
Imports Total	932,037	940,293	996,251
Exports to EU	214,635	189,047	162,422
Exports to Other Countries	160,283	184,641	195,564
Exports Total	374,918	373,688	357,986
Exports to EU/Total Exports	57.2%	50.6%	45.4%
Imports from EU/Total Imports	41.3%	39.2%	34.1%
Trade Balance	- 557,119	- 566,605	- 638,265
EU Trade Balance	- 170,445	- 179,987	- 176,956

Table 72
Portugal
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	389,406	456,031	548,285	567,090
Imports Extra-EU	147,827	157,373	193,407	193,146
Imports Total	537,233	613,404	741,692	760,236
Exports Intra-EU	77,932	63,928	86,892	77,545
Exports Extra-EU	32,205	39,548	37,637	24,386
Exports Total	110,137	103,476	124,529	101,931
Extra-EU/Intra-EU Exports	41.3%	61.9%	43.3%	31.4%
Extra-EU/Intra-EU Imports	38.0%	34.5%	35.3%	34.1%
Trade Balance	- 427,096	- 509,928	- 617,163	- 658,305
Extra EU Trade Balance	- 115,622	- 117,825	- 155,770	- 168,760

Table 73
Spain
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	1,557,631	1,724,147	1,892,101	1,696,387
Imports Extra-EU	1,637,332	1,596,337	1,705,594	1,559,130
Imports Total	3,194,963	3,320,484	3,597,695	3,255,517
Exports Intra-EU	706,303	721,298	934,792	862,182
Exports Extra-EU	273,453	267,377	397,263	431,074
Exports Total	979,756	988,675	1,332,055	1,293,256
Extra-EU/Intra-EU Exports	38.7%	37.1%	42.5%	50.0%
Extra-EU/Intra-EU Imports	105.1%	92.6%	90.1%	91.9%
Trade Balance	- 2,215,207	- 2,331,809	- 2,265,640	- 1,962,261
Extra EU Trade Balance	- 1,363,879	- 1,328,960	- 1,308,331	- 1,128,056

IT & Telecoms	1990	1991	1992
Imports from EU	914,468	904,751	792,091
Imports from Other Countries	1,448,426	1,414,003	1,449,925
Imports Total	2,362,894	2,318,754	2,242,017
Exports to EU	1,328,073	1,220,690	1,033,776
Exports to Other Countries	961,270	1,029,722	1,052,070
Exports Total	2,289,343	2,250,412	2,085,845
Exports to EU/Total Exports	58.0%	54.2%	49.6%
Imports from EU/Total Imports	38.7%	39.0%	35.3%
Trade Balance	- 73,551	- 68,342	- 156,171
EU Trade Balance	413,605	315,939	241,684

Table 74
Sweden
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1990	1991	1992
Imports from EU	1,601,842	1,464,492	1,490,222
Imports from Other Countries	851,285	837,322	853,018
Imports Total	2,453,127	2,301,813	2,343,240
Exports to EU	415,700	412,559	444,870
Exports to Other Countries	219,099	248,631	233,122
Exports Total	634,799	661,189	677,991
Exports to EU/Total Exports	65.5%	62.4%	65.6%
Imports from EU/Total Imports	65.3%	63.6%	63.6%
Trade Balance	- 1,818,328	- 1,640,624	- 1,665,249
EU Trade Balance	- 1,186,142	- 1,051,933	- 1,045,352

Table 75
Switzerland
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	5,270,167	5,232,171	5,116,971	5,286,159
Imports Extra-EU	6,758,613	6,255,547	6,292,510	6,663,576
Imports Total	12,028,780	11,487,718	11,409,481	11,949,735
Exports Intra-EU	5,585,981	5,933,219	6,195,308	5,773,592
Exports Extra-EU	3,332,932	3,013,240	3,132,322	3,136,566
Exports Total	8,918,913	8,946,459	9,327,630	8,910,158
Extra-EU/Intra-EU Exports	59.7%	50.8%	50.6%	54.3%
Extra-EU/Intra-EU Imports	128.2%	119.6%	123.0%	126.1%
Trade Balance	- 3,109,867	- 2,541,259	- 2,081,851	- 3,039,577
Extra EU Trade Balance	- 3,425,681	- 3,242,307	- 3,160,188	- 3,527,010

Table 76
United Kingdom
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

Table 77
EU
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1989	1990	1991	1992
Imports Intra-EU	27,026,765	28,847,211	30,595,059	30,944,466
Imports Extra-EU	25,879,241	26,002,264	28,744,773	29,531,323
Imports Total	52,906,006	54,849,475	59,339,832	60,475,789
Exports Intra-EU	27,394,670	27,864,827	28,108,944	27,330,115
Exports Extra-EU	12,602,005	12,407,856	13,703,411	14,377,370
Exports Total	39,996,675	40,272,683	41,812,355	41,707,485
Extra-EU/Intra-EU Exports	46.0%	44.5%	48.8%	52.6%
Extra-EU/Intra-EU Imports	95.8%	90.1%	94.0%	95.4%
Trade Balance	- 12,909,331	- 14,576,792	- 17,527,477	- 18,768,304
Extra EU Trade Balance	- 13,277,236	- 13,594,408	- 15,041,362	- 15,153,953

Table 78
EFTA
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1990	1991	1992
Imports from EU	3,025,051	2,808,869	2,729,053
Imports from Other Countries	2,953,820	2,918,261	3,032,775
Imports Total	5,978,871	5,727,130	5,761,828
Exports to EU	1,164,983	1,182,184	1,357,224
Exports to Other Countries	1,100,447	993,967	1,032,408
Exports Total	2,265,430	2,176,151	2,389,632
Exports to EU/Total Exports	51.4%	54.3%	56.8%
Imports from EU/Total Imports	50.6%	49.0%	47.4%
Trade Balance	- 3,713,441	- 3,550,979	- 3,372,196
EU Trade Balance	- 1,860,068	- 1,626,684	- 1,371,829

Table 79
USA
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

IT & Telecoms	1990	1991	1992
Imports from EU	1,984,868	2,394,523	2,933,397
Imports from Other Countries	11,639,595	14,070,346	20,241,229
Imports Total	13,624,463	16,464,869	23,174,626
Exports to EU	9,766,174	9,879,282	10,924,965
Exports to Other Countries	13,945,705	11,353,975	18,480,836
Exports Total	23,711,879	21,233,257	29,405,801
Exports to EU/Total Exports	41.2%	46.5%	37.2%
Imports from EU/Total Imports	14.6%	14.5%	12.7%
Trade Balance	10,087,416	4,768,388	6,231,175
EU Trade Balance	7,781,306	7,484,760	7,991,568

IT & Telecoms	1990	1991	1992
Imports from EU	270,464	342,901	501,474
Imports from Other Countries	4,362,649	5,378,072	5,194,920
Imports Total	4,633,113	5,720,974	5,696,394
Exports to EU	6,818,184	8,716,554	9,223,844
Exports to Other Countries	15,762,592	19,217,440	20,586,164
Exports Total	22,580,776	27,933,993	29,810,008
Exports to EU/Total Exports	30.2%	31.2%	30.9%
Imports from EU/Total Imports	5.8%	6.0%	8.8%
Trade Balance	17,947,663	22,213,020	24,113,613
EU Trade Balance	6,547,720	8,373,652	8,722,370

Table 80
Japan
Trade in IT and Telecommunications Hardware
(Thousands of ECU)

9. Market Structures and Penetration of ICT

The different markets in Europe freely share certain features with their neighbours, but equally the degree of variation amongst the countries is also considerable. The tables which follow attempt to illustrate the degree to which countries within the EU and EFTA are distinguished in terms of their competitive fabric, trade balance (EU countries only) and overall use of IT and telecommunication.

Tables 81 to *93* present a number of ratios for the major EU and EFTA markets. These tables include different measures of industry leadership or concentration, ratios comparing the value of the ICT market to gross domestic product and population.

The market share of a leader in a particular market is for the purposes of this study considered a composite measure. The nature of the IT market in Europe makes this a necessity. Thus, it cannot be assumed that a figure under this heading gives the total market share of a single national supplier. The composite measure is designed to assess the degree to which the market leaders in various related sectors dominate those markets. A similar principle is used in arriving at a figure for market concentration. These figures refer to the cumulative market share of the top ten vendors, in each year, with the composition of the top ten varying each year. The software and services markets are here defined in terms which stress the independent structures. They are not therefore sensitive to the balance of power between the traditional hardware suppliers and the independent specialists. This is justified on the basis of the theory of de-integration of the industry and because of the predominance of the hardware suppliers in terms of the systems software that is essential for the operation of the machines, but not intimately associated with the solution of user-oriented problems.

Throughout the EU and EFTA the ratios of the value of the IT market compared to gross national product, or of the IT market value to the total population, vary considerably. *Tables 94* to *99* summarise the variation of these ratios by country for the period 1990 to 1992.

Table 81
Austria
Market Structures
and Penetration of ICT

Austria		1990	1991	1992
Industry Leader's Share	Hardware	28.8%	28.0%	23.8%
	Software	0.6%	0.8%	1.7%
	Services	1.5%	1.8%	2.6%
Industry Concentration (Top 10 Vendors)	Hardware	80.2%	73.7%	60.1%
	Software	3.9%	5.3%	9.8%
	Services	9.8%	12.6%	15.8%
Market Comparisons	IT Market versus GDP	1.80%	1.75%	1.61%
	Per Capita IT Expenditure (ECU)	284	282	293
	ICT Market versus GDP	4.05%	3.93%	3.72%
	Per Capita ICT Expenditure (ECU)	640	634	677

Table 82
Belgium/Luxembourg
Market Structures
and Penetration of ICT

Belgium/Luxembourg		1990	1991	1992
Industry Leader's Share	Hardware	31.3%	27.8%	20.8%
	Software	2.0%	2.1%	4.1%
	Services	1.8%	2.5%	5.1%
Industry Concentration (Top 10 Vendors)	Hardware	79.4%	76.5%	58.3%
	Software	12.2%	12.6%	14.8%
	Services	8.2%	12.2%	21.1%
Market Comparisons	IT Market versus GDP	2.45%	2.40%	2.20%
	Per Capita IT Expenditure (ECU)	350	349	353
	ICT Market versus GDP	4.44%	4.34%	4.11%
	Per Capita ICT Expenditure (ECU)	635	633	660

Table 83
Denmark
Market Structures
and Penetration of ICT

Denmark		1990	1991	1992
Industry Leader's Share	Hardware	47.7%	43.9%	30.9%
	Software	2.2%	2.3%	3.6%
	Services	8.7%	9.1%	21.5%
Industry Concentration (Top 10 Vendors)	Hardware	85.6%	82.2%	62.9%
	Software	12.4%	12.7%	14.9%
	Services	24.7%	24.2%	44.8%
Market Comparisons	IT Market versus GDP	2.94%	2.93%	2.60%
	Per Capita IT Expenditure (ECU)	570	570	554
	ICT Market versus GDP	5.12%	5.09%	4.72%
	Per Capita ICT Expenditure (ECU)	991	990	1,008

Finland		1990	1991	1992
Industry Leader's Share	Hardware	23.0%	20.4%	14.2%
	Software	11.3%	9.0%	4.7%
	Services	8.0%	12.4%	11.0%
Industry Concentration (Top 10 Vendors)	Hardware	70.1%	63.5%	51.1%
	Software	40.2%	33.8%	23.6%
	Services	25.9%	35.2%	30.2%
Market Comparisons	IT Market versus GDP	1.82%	2.02%	2.02%
	Per Capita IT Expenditure (ECU)	386	384	351
	ICT Market versus GDP	2.97%	3.30%	3.53%
	Per Capita ICT Expenditure (ECU)	632	628	613

Table 84
Finland
Market Structures and Penetration of ICT

France		1990	1991	1992
Industry Leader's Share	Hardware	28.1%	26.6%	21.2%
	Software	6.0%	6.8%	6.7%
	Services	12.8%	12.8%	10.0%
Industry Concentration (Top 10 Vendors)	Hardware	79.0%	76.6%	62.8%
	Software	42.0%	23.5%	19.0%
	Services	72.7%	23.5%	33.4%
Market Comparisons	IT Market versus GDP	2.20%	2.19%	2.00%
	Per Capita IT Expenditure (ECU)	356	355	362
	ICT Market versus GDP	4.29%	4.29%	3.98%
	Per Capita ICT Expenditure (ECU)	695	694	720

Table 85
France
Market Structures and Penetration of ICT

Germany		1990	1991	1992
Industry Leader's Share	Hardware	24.6%	27.7%	19.6%
	Software	3.3%	3.4%	4.3%
	Services	2.2%	1.9%	3.6%
Industry Concentration (Top 10 Vendors)	Hardware	72.3%	74.2%	56.2%
	Software	16.2%	12.9%	18.0%
	Services	11.6%	9.9%	16.2%
Market Comparisons	IT Market versus GDP	2.17%	2.07%	1.94%
	Per Capita IT Expenditure (ECU)	345	344	361
	ICT Market versus GDP	4.54%	4.31%	4.20%
	Per Capita ICT Expenditure (ECU)	719	717	781

Table 86
Germany
Market Structures and Penetration of ICT

Table 87
Italy
Market Structures and Penetration of ICT

Italy		1990	1991	1992
Industry Leader's Share	Hardware	33.8%	33.1%	31.9%
	Software	2.5%	2.3%	2.1%
	Services	15.9%	16.2%	6.9%
Industry Concentration (Top 10 Vendors)	Hardware	90.2%	78.9%	69.0%
	Software	14.5%	14.0%	13.2%
	Services	44.3%	45.0%	40.1%
Market Comparisons	IT Market versus GDP	1.49%	1.42%	1.35%
	Per Capita IT Expenditure (ECU)	218	221	227
	ICT Market versus GDP	3.32%	3.16%	3.08%
	Per Capita ICT Expenditure (ECU)	485	490	518

Table 88
Netherlands
Market Structures and Penetration of ICT

Netherlands		1990	1991	1992
Industry Leader's Share	Hardware	24.9%	23.0%	19.5%
	Software	3.2%	2.3%	1.8%
	Services	25.5%	19.0%	28.2%
Industry Concentration (Top 10 Vendors)	Hardware	78.1%	74.7%	61.1%
	Software	13.0%	10.4%	12.8%
	Services	75.2%	73.7%	67.7%
Market Comparisons	IT Market versus GDP	2.66%	2.62%	2.36%
	Per Capita IT Expenditure (ECU)	389	389	387
	ICT Market versus GDP	5.11%	5.02%	4.65%
	Per Capita ICT Expenditure (ECU)	746	746	762

Table 89
Norway
Market Structures and Penetration of ICT

Norway		1990	1991	1992
Industry Leader's Share	Hardware	24.1%	23.5%	14.1%
	Software	3.1%	4.2%	4.2%
	Services	2.5%	3.8%	3.9%
Industry Concentration (Top 10 Vendors)	Hardware	70.2%	63.9%	50.8%
	Software	14.4%	16.3%	26.0%
	Services	20.1%	21.4%	25.0%
Market Comparisons	IT Market versus GDP	2.92%	2.92%	2.71%
	Per Capita IT Expenditure (ECU)	560	559	547
	ICT Market versus GDP	5.31%	5.32%	5.19%
	Per Capita ICT Expenditure (ECU)	1,018	1,017	1,050

Spain		1990	1991	1992
Industry Leader's Share	Hardware	32.4%	28.8%	25.0%
	Software	4.8%	3.7%	4.8%
	Services	19.9%	13.0%	15.3%
Industry Concentration (Top 10 Vendors)	Hardware	77.5%	68.0%	59.6%
	Software	30.7%	11.7%	14.3%
	Services	40.7%	33.8%	26.1%
Market Comparisons	IT Market versus GDP	1.50%	1.40%	1.25%
	Per Capita IT Expenditure (ECU)	146	146	143
	ICT Market versus GDP	3.95%	3.68%	3.34%
	Per Capita ICT Expenditure (ECU)	384	383	382

Table 90
Spain
Market Structures and Penetration of ICT

Sweden		1990	1991	1992
Industry Leader's Share	Hardware	34.8%	30.3%	22.5%
	Software	5.8%	2.5%	2.8%
	Services	7.2%	12.3%	8.0%
Industry Concentration (Top 10 Vendors)	Hardware	79.4%	78.9%	57.1%
	Software	24.7%	15.6%	17.9%
	Services	24.0%	26.3%	22.4%
Market Comparisons	IT Market versus GDP	2.98%	2.88%	2.59%
	Per Capita IT Expenditure (ECU)	611	611	574
	ICT Market versus GDP	6.03%	5.83%	5.52%
	Per Capita ICT Expenditure (ECU)	1,235	1,234	1,226

Table 91
Sweden
Market Structures and Penetration of ICT

Switzerland		1990	1991	1992
Industry Leader's Share	Hardware	31.0%	26.2%	20.8%
	Software	0.1%	0.6%	1.6%
	Services	1.8%	1.6%	5.9%
Industry Concentration (Top 10 Vendors)	Hardware	77.6%	68.8%	57.6%
	Software	0.8%	3.8%	5.6%
	Services	11.8%	10.1%	11.6%
Market Comparisons	IT Market versus GDP	2.76%	2.70%	2.65%
	Per Capita IT Expenditure (ECU)	714	711	730
	ICT Market versus GDP	5.89%	5.78%	5.71%
	Per Capita ICT Expenditure (ECU)	1,527	1,520	1,573

Table 92
Switzerland
Market Structures and Penetration of ICT

Table 93
United Kingdom
Market Structures
and Penetration of ICT

United Kingdom		1990	1991	1992
Industry Leader's Share	Hardware	22.3%	19.9%	14.3%
	Software	3.3%	4.9%	4.3%
	Services	3.4%	4.2%	6.2%
Industry Concentration (Top 10 Vendors)	Hardware	70.9%	72.4%	52.5%
	Software	15.2%	17.4%	17.1%
	Services	18.6%	23.5%	30.9%
Market Comparisons	IT Market versus GDP	2.52%	2.44%	2.41%
	Per Capita IT Expenditure (ECU)	330	329	340
	ICT Market versus GDP	5.17%	5.00%	4.89%
	Per Capita ICT Expenditure (ECU)	676	675	691

Table 94
Market Structures and
Penetration of ICT,
per Capita IT
Expenditure,
ECUs

	1990	1991	1992	1993
Austria	284	282	293	306
Belgium/Luxemb.	350	349	353	365
Denmark	570	570	554	588
Finland	386	384	351	369
France	356	355	362	358
Germany	345	344	361	365
Greece	38	37	43	51
Ireland	171	170	181	190
Italy	218	221	227	227
Netherlands	389	389	387	400
Norway	560	559	547	565
Portugal	66	66	79	92
Spain	146	146	143	137
Sweden	611	611	574	611
Switzerland	714	711	730	744
United Kingdom	330	329	340	349
EU + EFTA	306	306	313	318
US	440	469	501	531
Japan	247	247	229	220

Table 95
Market Structures and
Penetration of ICT,
IT% GDP

	1990	1991	1992	1993
Austria	1.80	1.75	1.61	1.63
Belgium/Luxemb.	2.45	2.40	2.20	2.23
Denmark	2.94	2.93	2.60	2.71
Finland	1.82	2.02	2.02	2.11
France	2.20	2.19	2.00	1.96
Germany	2.17	2.07	1.94	1.91
Greece	0.74	0.70	0.73	0.74
Ireland	1.81	1.79	1.71	1.71
Italy	1.49	1.42	1.35	1.31
Netherlands	2.66	2.62	2.36	2.42
Norway	2.92	2.92	2.71	2.70
Portugal	1.41	1.23	1.20	1.29
Spain	1.50	1.40	1.25	1.16
Sweden	2.98	2.88	2.59	2.76
Switzerland	2.76	2.70	2.65	2.68
United Kingdom	2.52	2.44	2.41	2.38
EU + EFTA	2.13	2.06	1.93	1.91
US	2.61	2.74	2.83	2.87
Japan	2.72	2.41	2.04	1.91

	1990	1991	1992	1993
Austria	355	352	384	414
Belgium/Luxemb.	285	284	307	330
Denmark	421	420	454	493
Finland	246	244	262	277
France	339	339	358	379
Germany	375	373	420	452
Greece	110	108	112	114
Ireland	311	310	318	322
Italy	267	269	291	313
Netherlands	357	357	375	395
Norway	458	458	503	540
Portugal	85	85	95	105
Spain	238	237	239	247
Sweden	624	624	652	673
Switzerland	813	809	843	879
United Kingdom	346	345	351	361
EU + EFTA	329	329	351	371
US	779	525	554	585
Japan	256	251	264	275

Table 96
Market Structures and Penetration of ICT, per Capita Telecommunication Expenditure, ECUs

	1990	1991	1992	1993
Austria	2.25	2.18	2.11	2.21
Belgium/Luxemb.	1.99	1.95	1.91	2.01
Denmark	2.17	2.16	2.13	2.27
Finland	1.16	1.28	1.51	1.59
France	2.10	2.09	1.98	2.07
Germany	2.36	2.25	2.26	2.37
Greece	2.17	2.05	1.88	1.68
Ireland	3.29	3.27	3.01	2.90
Italy	1.82	1.74	1.73	1.80
Netherlands	2.45	2.41	2.29	2.39
Norway	2.39	2.39	2.49	2.58
Portugal	1.81	1.57	1.45	1.48
Spain	2.45	2.28	2.09	2.08
Sweden	3.04	2.95	2.93	3.04
Switzerland	3.14	3.08	3.06	3.17
United Kingdom	2.65	2.56	2.49	2.46
EU + EFTA	2.29	2.21	2.16	2.23
US	4.63	3.07	3.13	3.16
Japan	2.83	2.45	2.35	2.40

Table 97
Market Structures and Penetration of ICT, Telecommunication, % GDP

	1990	1991	1992	1993
Austria	640	634	677	721
Belgium/Luxemb.	635	633	660	695
Denmark	991	990	1,008	1,081
Finland	632	628	613	646
France	695	694	720	736
Germany	719	717	781	817
Greece	147	146	155	165
Ireland	482	480	499	512
Italy	485	490	518	540
Netherlands	746	746	762	795
Norway	1,018	1,017	1,050	1,105
Portugal	151	151	174	196
Spain	384	383	382	384
Sweden	1,235	1,234	1,226	1,284
Switzerland	1,527	1,520	1,573	1,623
United Kingdom	676	675	691	710
EU + EFTA	635	635	664	689
US	1,218	994	1,055	1,116
Japan	503	499	493	495

Table 98
Market Structures and Penetration of ICT, per Capita ICT Expenditure, ECUs

	1990	1991	1992	1993
Austria	4.05	3.93	3.72	3.85
Belgium/Luxemb.	4.44	4.34	4.11	4.24
Denmark	5.12	5.09	4.72	4.98
Finland	2.97	3.30	3.53	3.70
France	4.29	4.29	3.98	4.03
Germany	4.54	4.31	4.20	4.28
Greece	2.91	2.75	2.61	2.43
Ireland	5.10	5.06	4.71	4.60
Italy	3.32	3.16	3.08	3.11
Netherlands	5.11	5.02	4.65	4.81
Norway	5.31	5.32	5.19	5.29
Portugal	3.22	2.80	2.65	2.77
Spain	3.95	3.68	3.34	3.24
Sweden	6.03	5.83	5.52	5.79
Switzerland	5.89	5.78	5.71	5.85
United Kingdom	5.17	5.00	4.89	4.84
EU + EFTA	4.42	4.28	4.10	4.14
US	7.24	5.82	5.95	6.03
Japan	5.55	4.87	4.39	4.31

Table 99
Market Structures and Penetration of ICT, ICT% GDP

10. Price Dynamics and End-user Issues

10.1. Price Trends

Recently, the state of the computing technologies, and most importantly the market supply and production infrastructures as well, has reached a level which has resulted in a reduction of the barriers to entry to such a level that the PC market has been pitched headlong into a vicious price war. The results of high and sometimes desperate levels of competition have included sharp reductions in the street price of PCs, both in Europe and the US. This is illustrated in *tables 100* and *101* and in *figures 13* and *16*. More recently, changes in pricing policies by certain vendors in the Japanese DOS PC sector suggest that a similar process may soon gather pace in the hitherto insulated proprietary dominated Japanese market.

Figure 13
Evolution of US Average Selling Prices for PCs

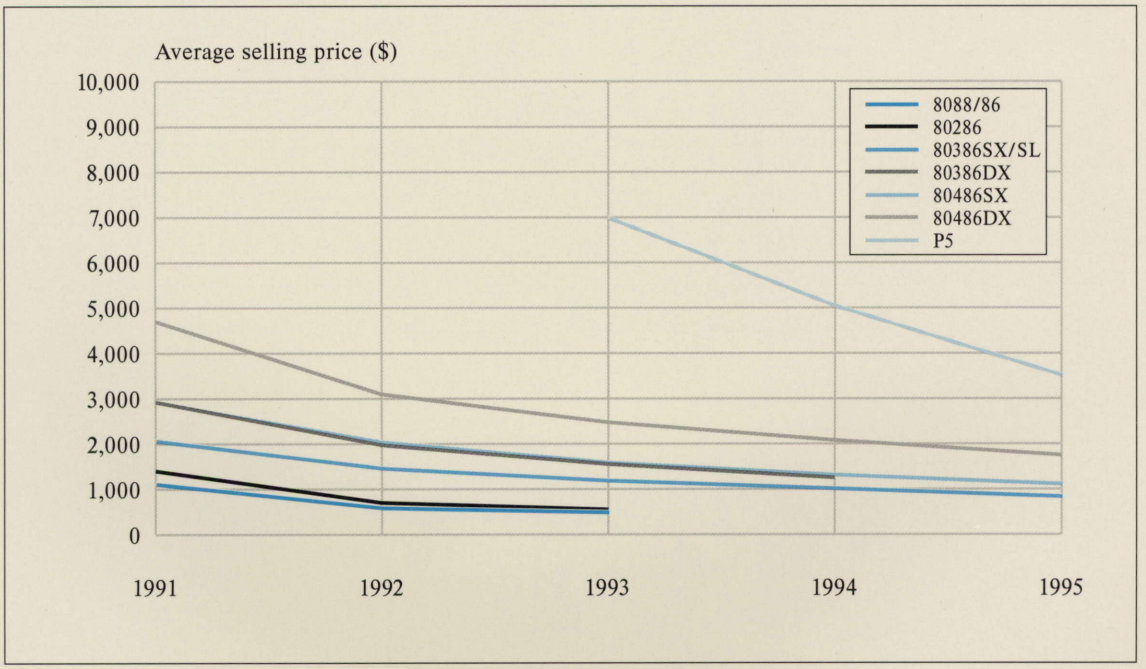


Table 100
Evolution of US Average Selling Prices for PCs

	1991	1992	1993	1994	1995
8088/86	1,130	620	520	N/A	N/A
80286	1,420	710	570	N/A	N/A
80386SX/SL	2,070	1,490	1,220	1,030	860
80386DX	2,930	1,990	1,550	1,270	N/A
80486SX	2,920	2,050	1,620	1,340	1,140
80486DX	4,690	3,100	2,480	2,080	1,770
P5	N/A	N/A	7,000	5,040	3,530

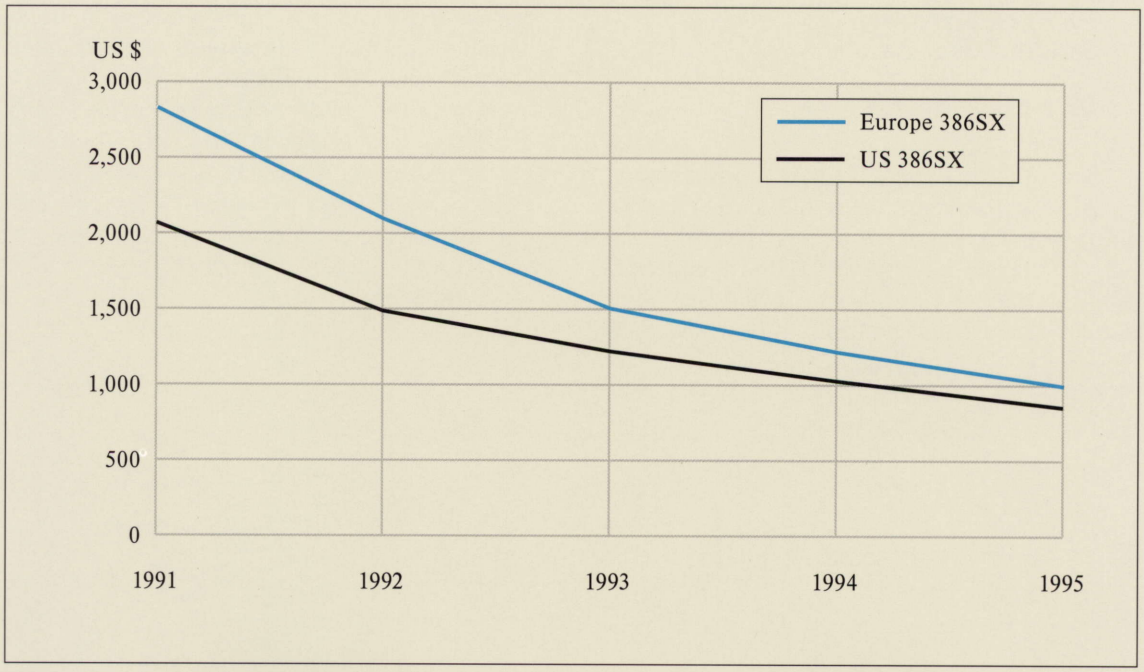


Figure 14
Convergence of Average Selling Prices for 386SX PCs. (US versus Europe)

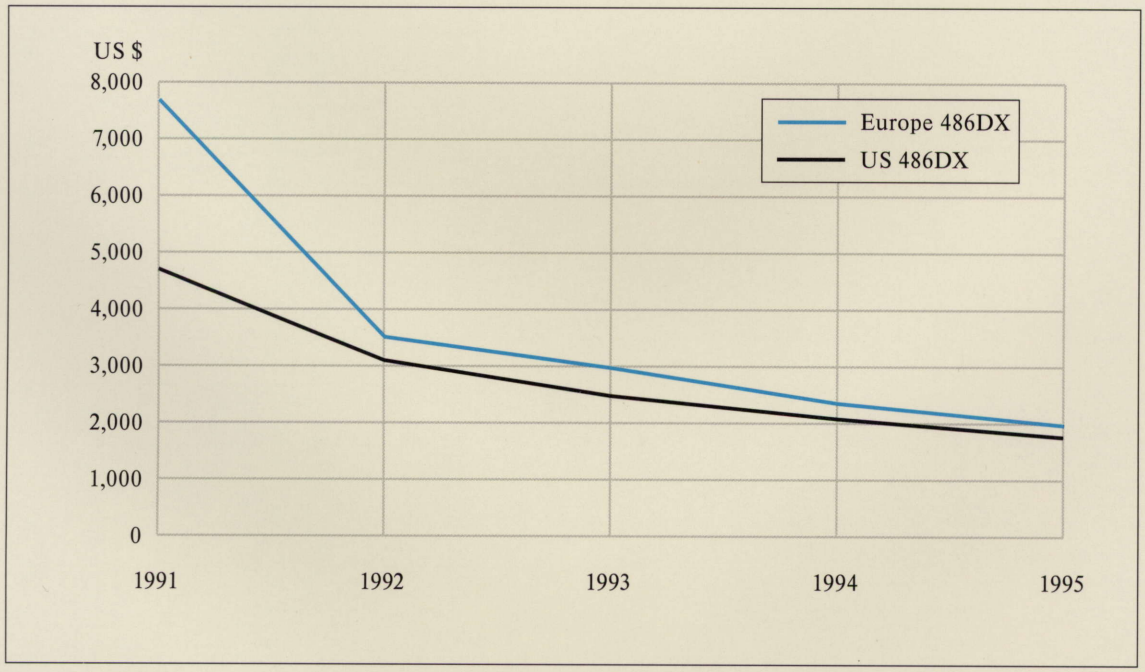


Figure 15
Convergence of Average Selling Prices for 486DX PCs. (US versus Europe)

Figure 16
Evolution of European Average Selling Prices for PCs

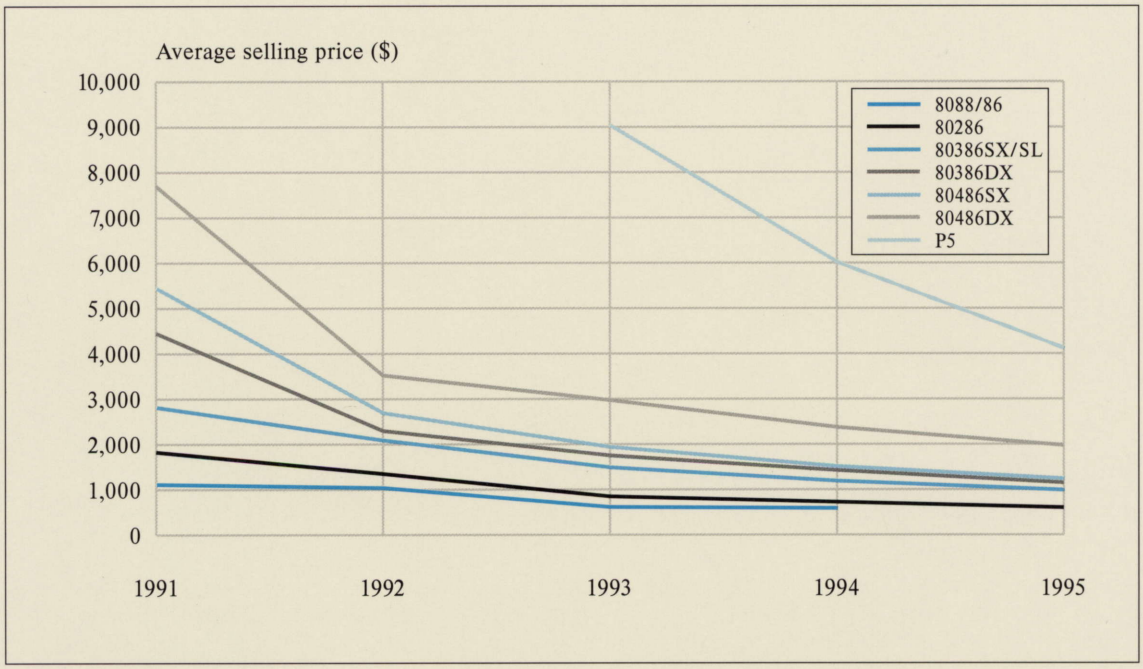


Table 101
Evolution of European Average Selling Prices for PCs

	1991	1992	1993	1994	1995
8088/86	1,128	1,060	628	610	N/A
80286	1,844	1,363	872	740	622
80386SX/SL	2,833	2,101	1,505	1,221	999
80386DX	4,439	2,304	1,769	1,428	1,152
80486SX	5,433	2,715	1,967	1,540	1,260
80486DX	7,690	3,520	2,980	2,374	1,979
P5	N/A	N/A	9,036	6,020	4,126

The situation in the PC market is interesting, for it combines a number of factors including technological progress, architectural trends, global competition and the regional variation of prices. To illustrate the last point, the emergence of new modes of international business has raised particular problems for vendors selling to large accounts where the final destination of the goods may well be a country with significantly different local prices. A number of major PC suppliers are currently grappling with this problem.

The recent experience of the PC industry gives a very demonstrable and extreme example of the dynamics of pricing in the computer hardware business. Although it is less obvious to the public gaze, many mainframe suppliers have also seen the prices they can charge undermined by recent market conditions.

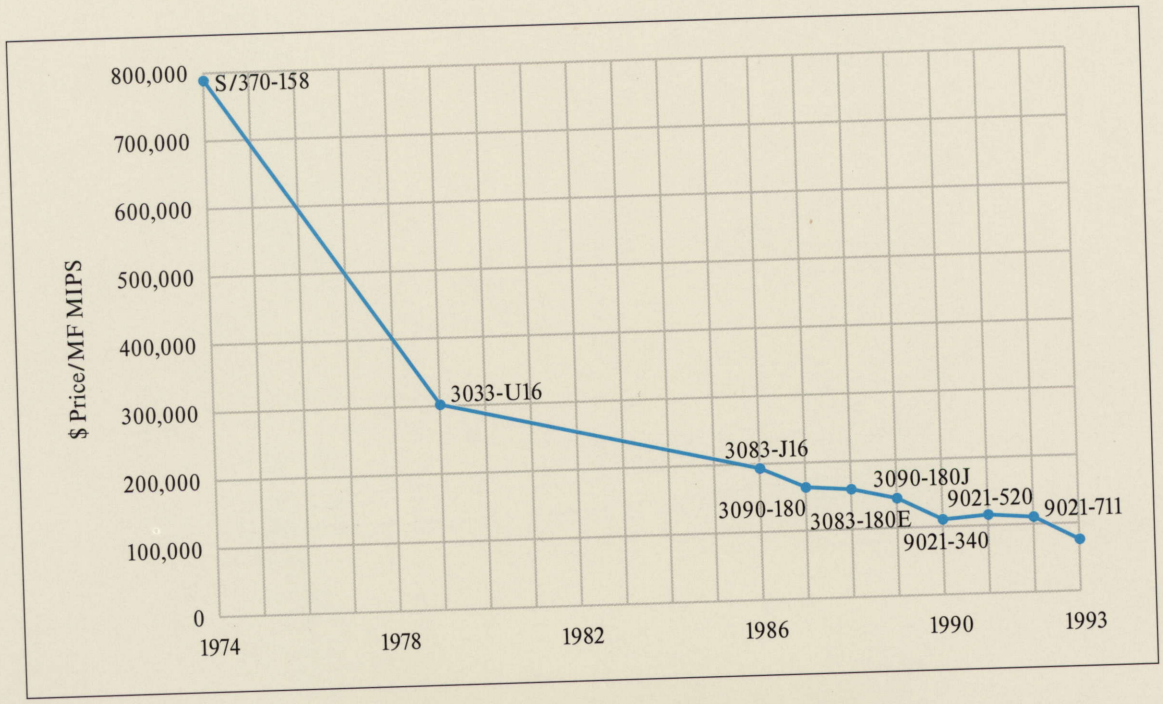


Figure 17
The Plunging Price of Mainframe MIPS

Figure 17 shows the extent to which the street price of mainframe MIPs (for several generations of IBM mainframe) has reduced over the last two decades. The dollar price of each MIP fell dramatically from the mid 1970s to the mid 1980s, but the rate at which prices have continued to fall has been more sedate during the past 10 years.

Figure 18 charts the decline in the price of selected hard disk drives from 1987 until today, reinforcing the notion that each of the major components of an information system have been getting cheaper to purchase as technology has improved and markets become more competitive.

More fundamental changes may result from the development of more complicated networks, requiring entirely new approaches to pricing. This is likely to be true for software more than anything else. Technologies capable of supporting infinitely flexible licensing schemes are coming to the market.

The IT industry has a difficult balance to achieve in the near future. The customers' desire for (amongst other things) dependability, flexibility, manageability, and lower costs has to be matched by a stable set suppliers' who are able to successfully and profitably differentiate themselves and their products and services.

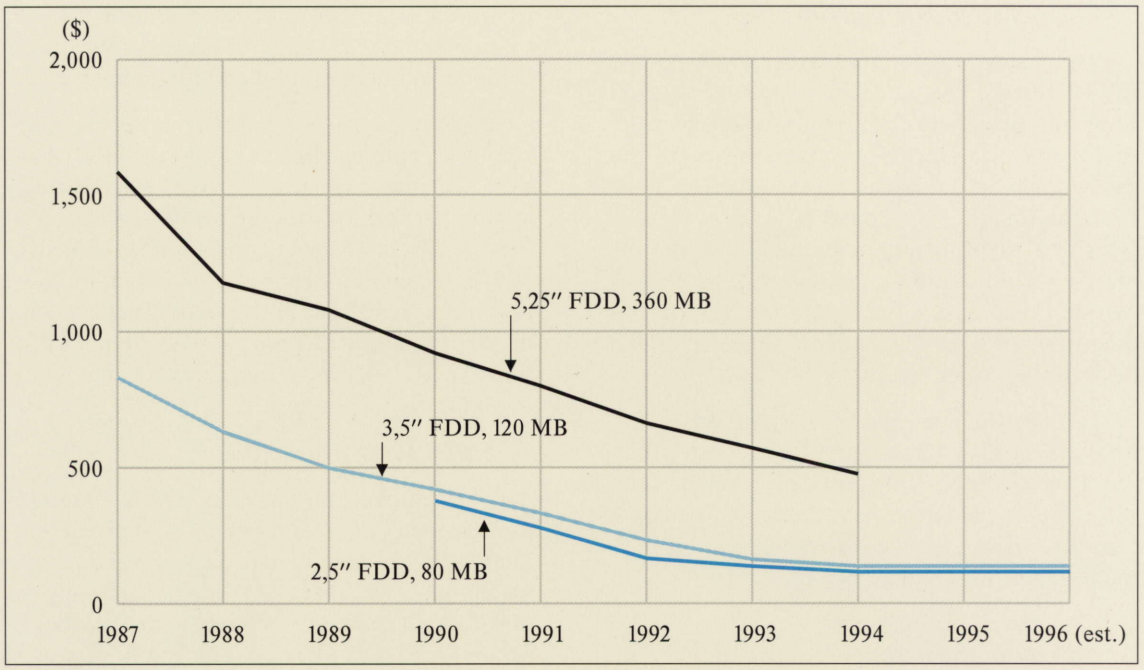


Figure 18 Dramatic Price Declines: Average Prices of Selected Hard Disk Drives, 1987-1996 (estimated)

10.2. End-user Markets

In order to better understand demand-side issues in the IT markets of the world, IDC conduct extensive end-user interviews on an annual basis. More specifically, the most recent annual research programme was designed to provide a comprehensive view of demand-side expectations of information systems professionals representing medium and large business entities. The survey focuses on the current IS climate, anticipated IT spending patterns, acceptance of new or emerging technologies (such as client/server) and implementation strategies.

Selected results from the surveys of Germany, France, the UK and Italy are given in the tables and figures which follow. In each case, the results are taken from extensive telephone surveys performed in 1993. Details of the specific questions discussed below.

Most important area of IT focus

The results to the question, "Which of the following will be your sites most important area of IT focus over the next 12 months?", summarised in *figure 19,* reveal that the two most pressing issues on the IT agenda in the short term are integrating central and end-user resources into a single enterprise information system, and developing and/or implementing strategic applications to improve competitiveness. As usual, considerable variation between countries is observed, with the need to improve competitiveness particularly keenly felt in France, whilst integration appears to be the priority in Germany.

Training and recruiting top quality staff is clearly not a priority for a signficant number of those questioned. However, controlling costs is a recurrent if not dominant theme, with the UK showing a greater interest in costs, and less concern over migrating from older to more modern platforms, than elsewhere.

Overall spending activity

The results to the question, "Which of the following best characterises your site's overall IT spending activity?", summarised in *figure 20,* reveal that the German respondents were the most likely to be investing in growing their IT capabilities across the major product classes. Nearly 42% of respondents reported rapidly growing needs, with an associated intention to invest in hardware, software and services. In contrast, only 21% of respondents reported stable or declining expenditure.

In the UK, France and Italy between 17% and 23% of respondents reported rapidly growing needs, whilst between 23% and 27% of respondents claimed to have sufficient hardware capacity, with an associated emphasis on investment in software and services.

Growth of mainframe and mini processing

The results to the question, "How will your site's total 1993 installed mainframe and minicomputer processing capacity compare with 1992?", summarised in *figure 21,* reveal that in each of Germany, the UK and Italy when suitably weighted such capacity is expected to increase by over 15% for the period discussed; whilst in France the increase is less but is still expected to exceed 13%.

Combined with a likely increase in the power installed in the form of PCs and workstations, this strongly suggests an increase in processing power (as measured in MIPs) firmly in the double digit range.

Attitudes towards client/server computing

The results to the question, "Which statement best describes your sites attitude towards so-called client/server computing?", summarised in *figure 22,* reveal that few dismiss the term as merely a buzzword or catch phrase. Indeed, there is widespread support for the concept and evidence of ongoing implementation effort.

Clearly client/server architectures are more keenly accepted in Germany and the UK, where over 60% of respondents either have already adopted or decided to adopt the new approach. In France, interest is also considerable, with over 50% of respondents showing significant interest, but in Italy over 50% of respondents either have no plans to embrace client/server computing, or regard it as a buzzword, or are unsure of how best to adopt the technology.

Open systems pursuit

The results to the question, "Is your organisation pursuing an open systems strategy?", summarised in *figure 23,* reveal that most of the organisations surveyed are. The lowest percentage of respondents claiming to pursue such a strategy occurs in France (57.6%), with the highest percentage reported for the UK (70.8%).

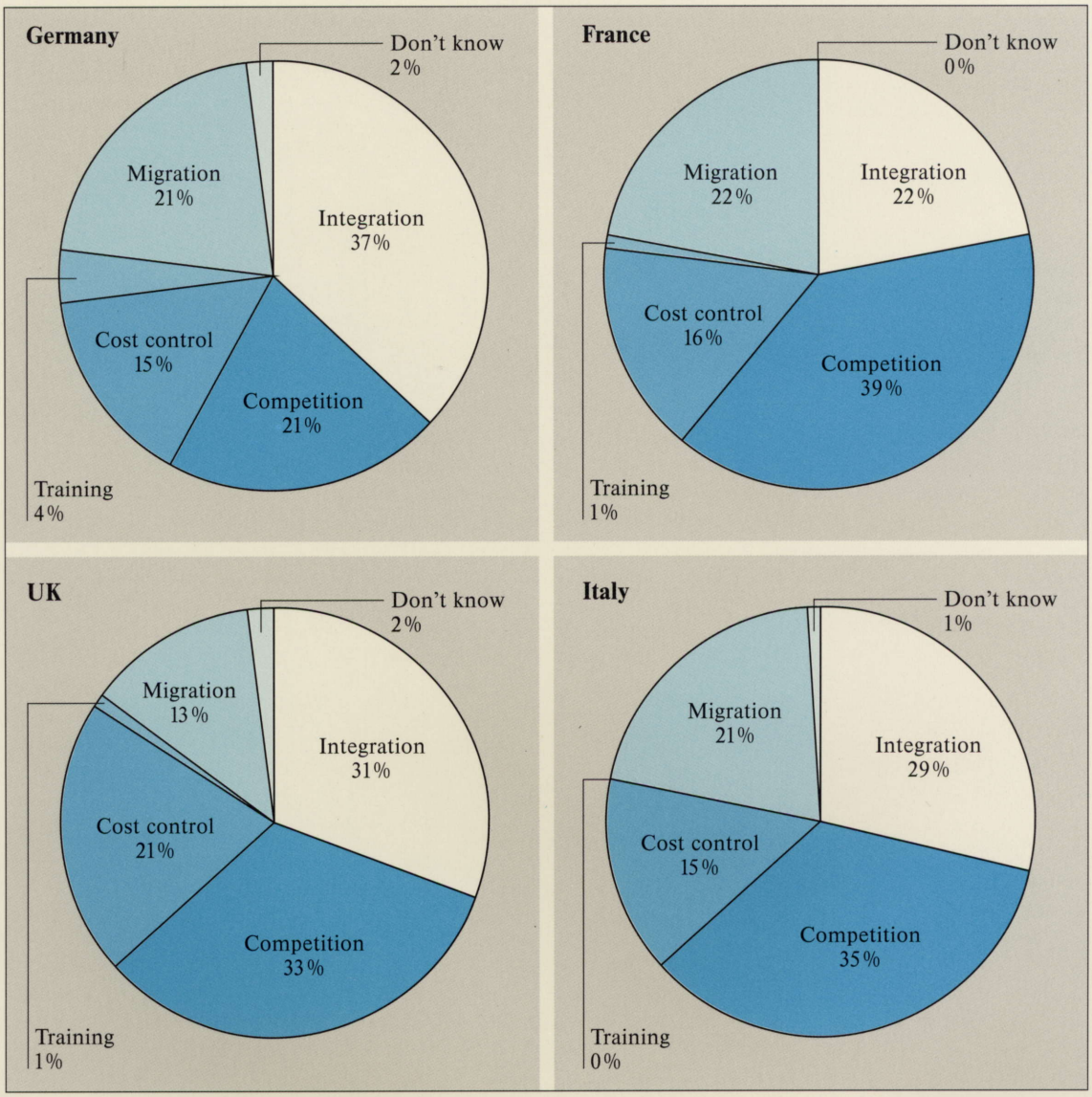
Proportions using LANs

The results to the question, "Does your site currently have installed or plan to install a local area network?", summarised in *figure 24,* reveal that between 70% and 80% of respondents have or plan to install a local area network.

Overall database strategy

The results to the question, "which of the following best describes your site's overall database strategy?", summarised in *figure 25,* reveal that in France and Italy for over 50% of respondents important databases currently reside on traditional host systems and are likely to stay that way. In the UK and Germany between 44% and 37% of respondents answer similarly. In Germany greater emphasis is placed on integrating central and end-user databases (33% of respondents). In the UK 32% of respondents declare an increasing intention to develop LAN server-based end-user databases.

Figure 19
Most Important Area of IT Focus, 1993



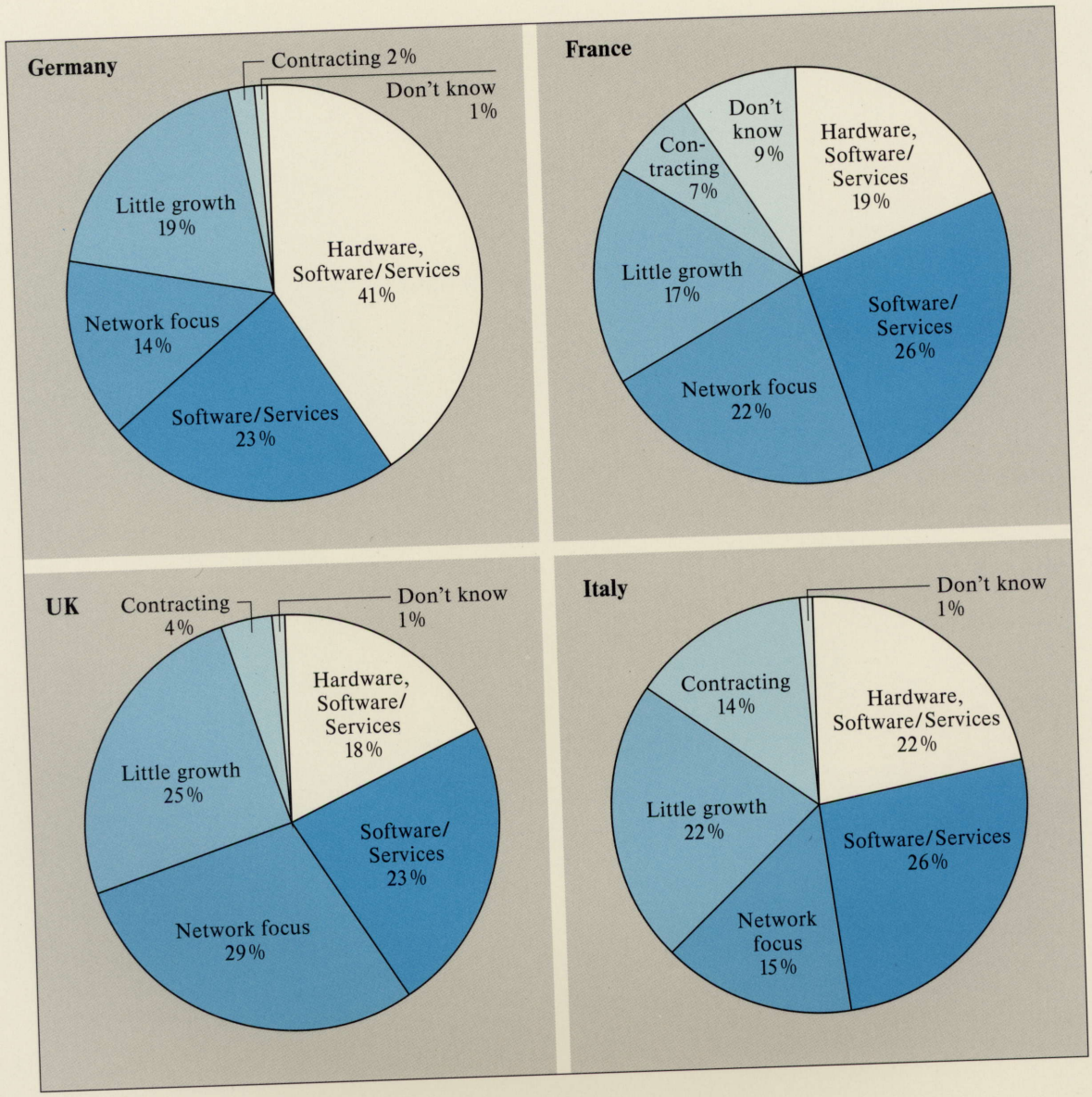
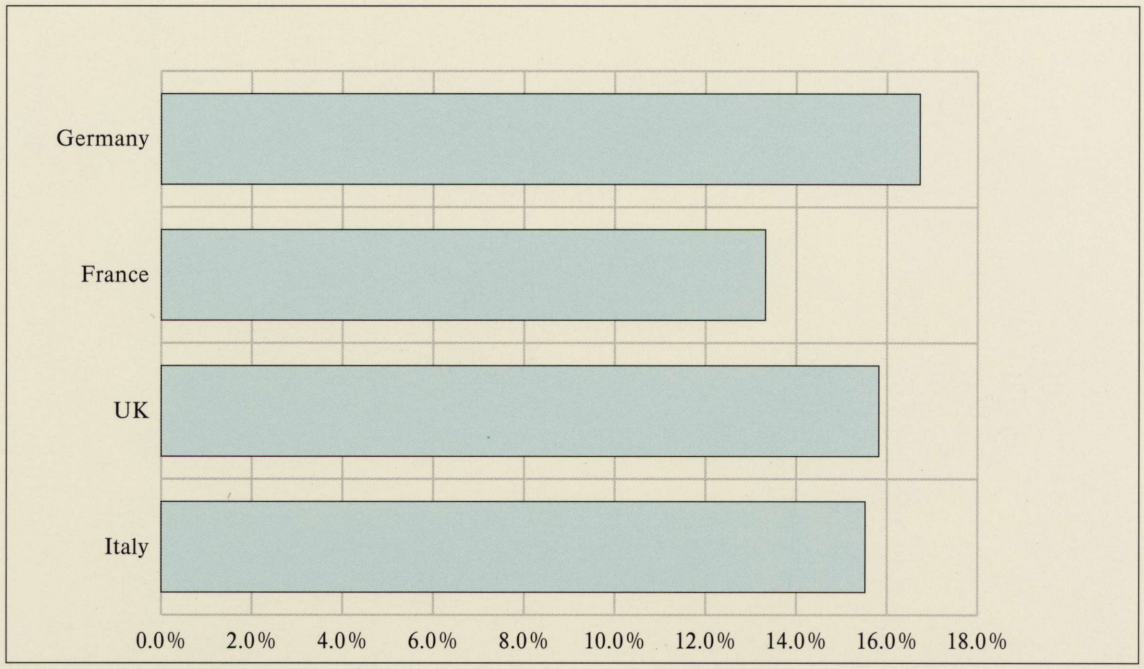


Figure 20
Overall Spending Activity, 1993

Figure 21
Growth Rate of Mainframe and Mini-processing Capacity, 1993



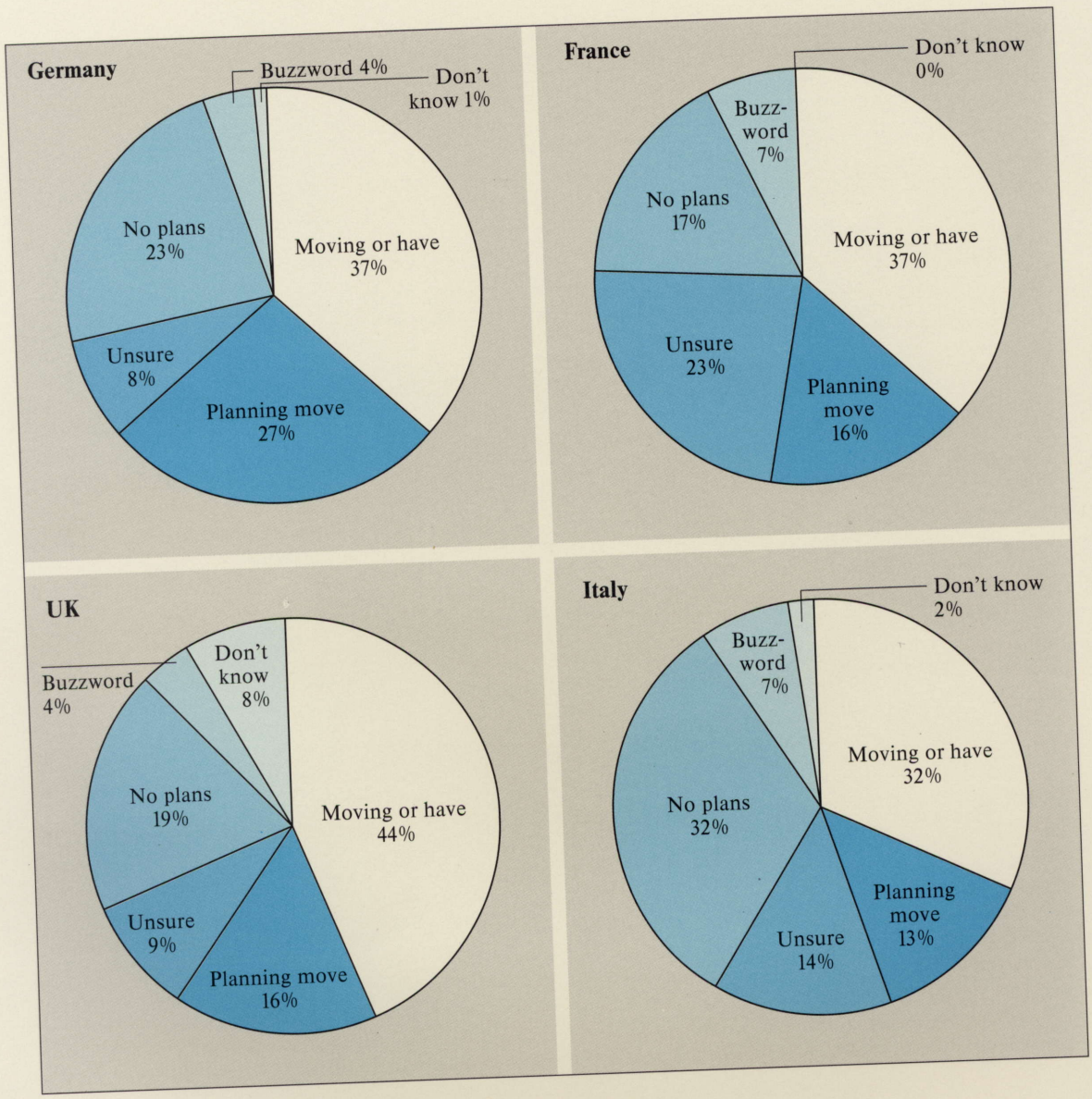


Figure 22
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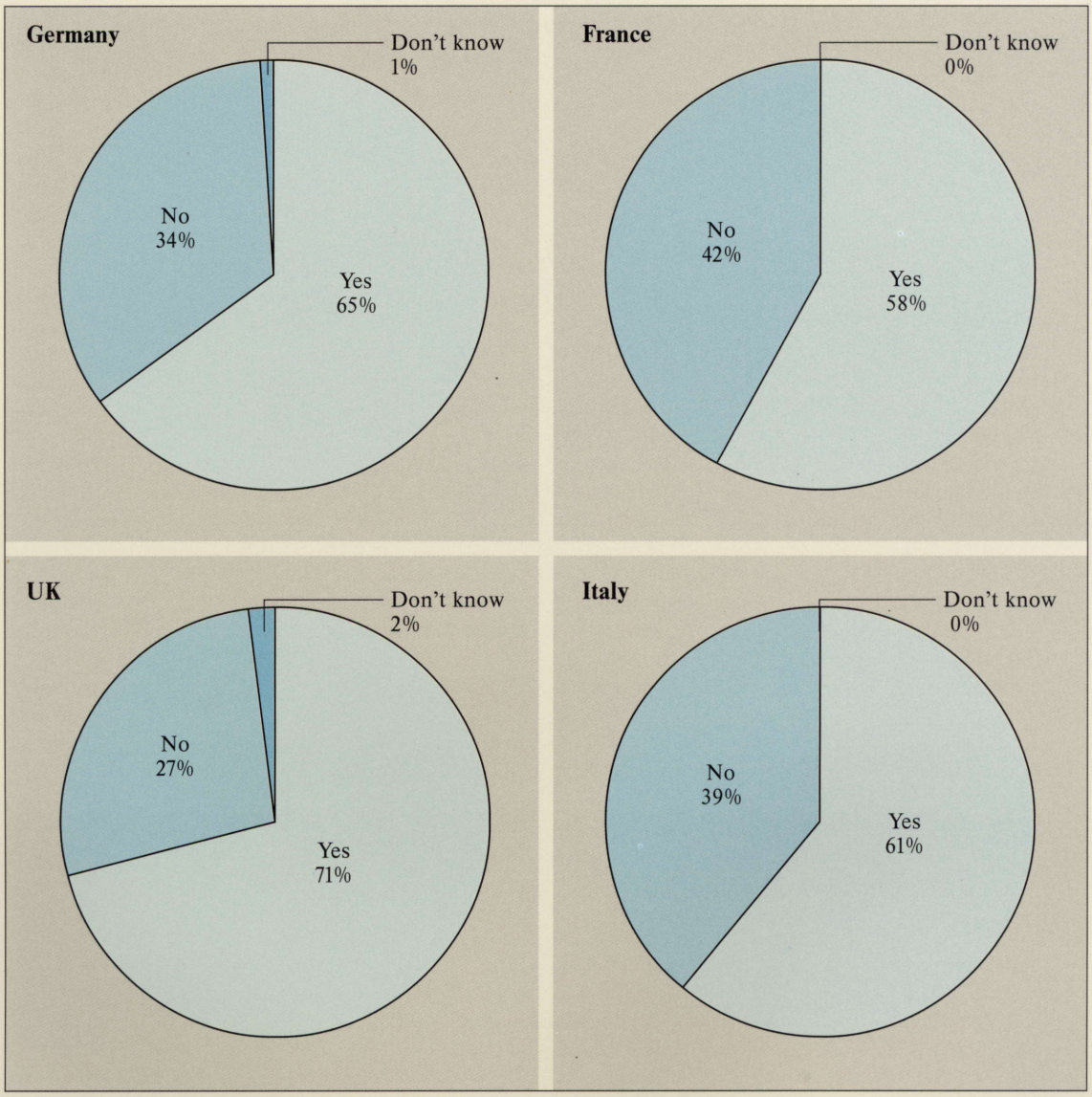
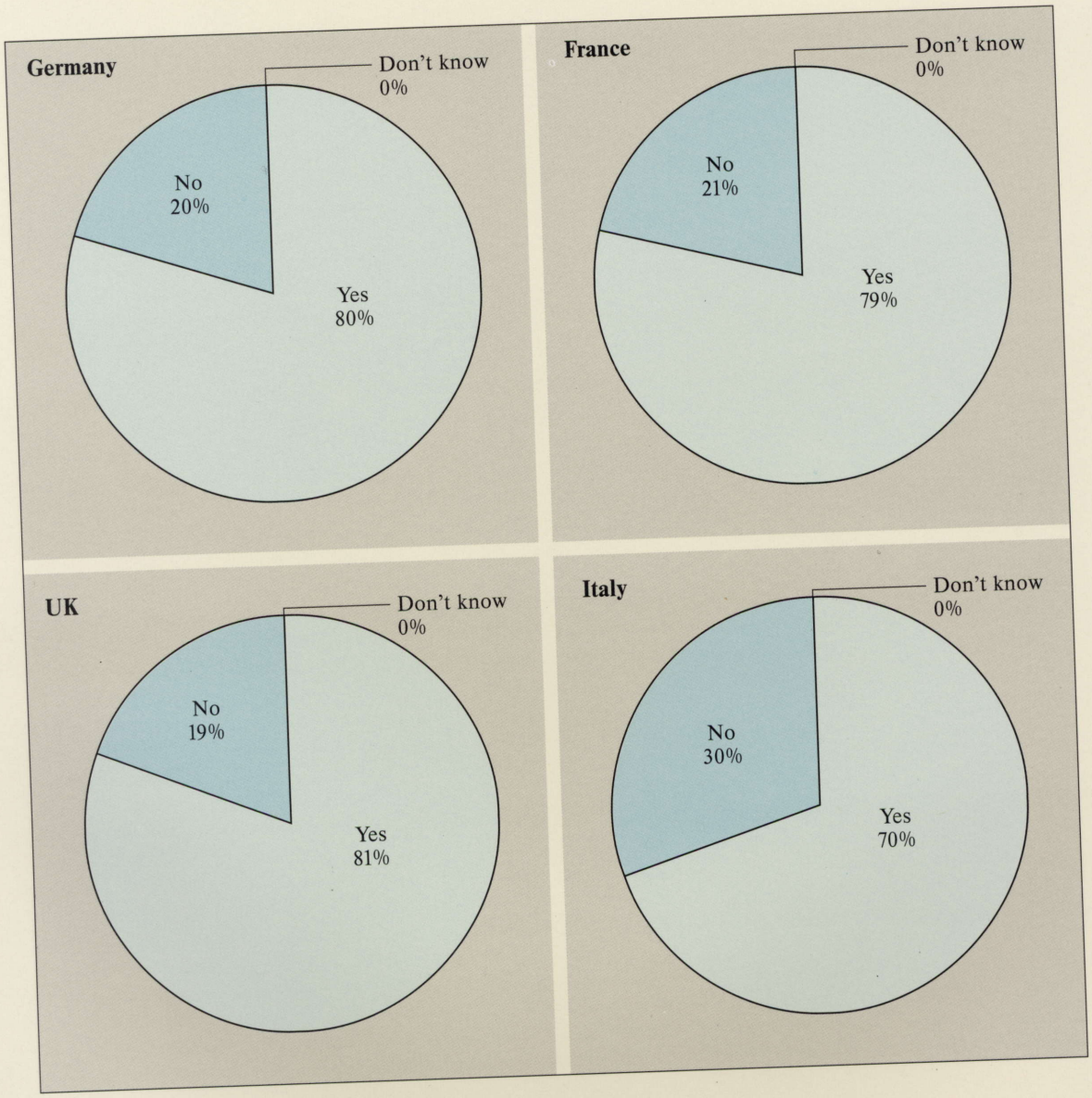
Figure 23
Proportions Pursuing an Open Systems Strategy. 1993





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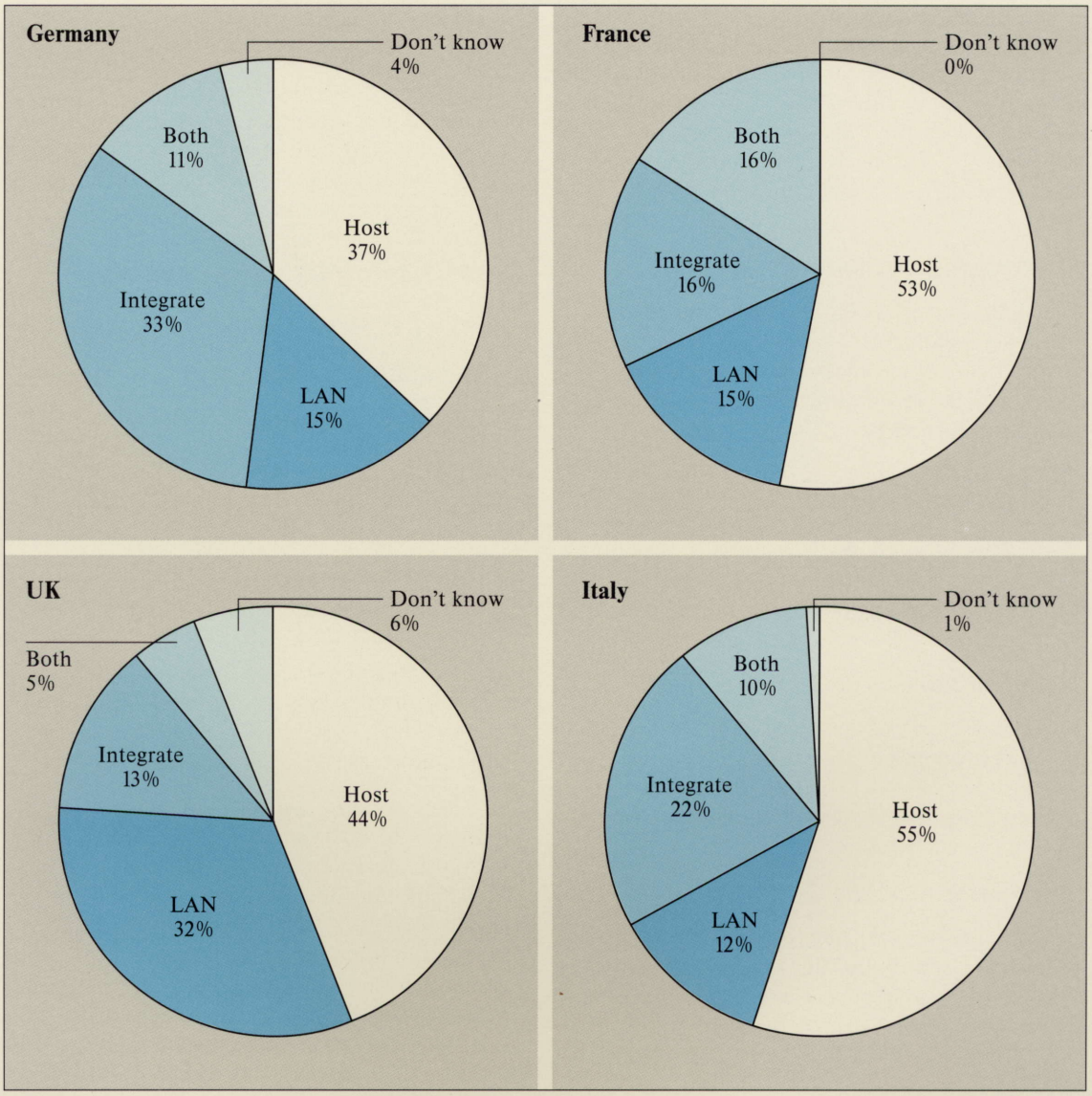

11. Definitions

The Statistical Section of the EITO is based upon a set of definitions and methodologies agreed between the EITO Task Force and IDC, and upon the European Community standards for trade statistics. These definitions are outlined below.

Information technology:

For the purposes of this study information technology refers to the combined industries of hardware for office machines, data processing equipment, data communications equipment, of software and services.

Information and communications technologies (ICT):

For the purposes of this study information and communications technologies refers to information technology plus telecommunications equipment and telecommunications services.

Market values:

All market values are in constant 1992 ECUs, therefore growth is expressed in local currencies (without the effects of changes in currency conversions). Trade data are reported in current ECUs.

Domestic markets:

Domestic market value is the revenue paid to primary vendors for office machines, DP systems, software and/or services for sale into the distribution channels or to the final customer. For product-specific definitions, see other terms below.

Unit shipments:

Unit shipments are the unit measure of hardware product sales by vendors to all distribution channels or to end-users. Units are counted as they leave suppliers and are not double-counted in the case of OEM relationships.

IT user budgets:

IT user budgets are investigated in IT user surveys. As these measure purchase intentions and behaviours that vary according to different geographic and time parameters, growth rates of IT user budgets do not match with growth rates of market values.

11.1. Information Technology

11.1.1. IT Hardware

Computer hardware

DP Systems include CPU(s) and basic peripherals (e.g., data storage devices, terminals, memory and peripherals), as well as revenue for new systems added to the installed base. Multiprocessor configurations are counted as single systems.

Multi-user systems group all large, medium and small scale systems (i.e., all computer systems except personal computers and single-user workstations). Multi-user computers are typically multitasking, multi-user systems which support and are principally marketed to support two or more users.

Large scale systems are either large general purpose or high speed scientific computers with average system values generally in excess of $ 1 million. Representative systems include IBM's 3090 and ES 9021s systems and their compatible and non-compatible competitors, as well as so called supercomputers. Currently shipping models in this category typically support over 128 users in a commercial environment.

Medium scale systems, which include traditional supermini class computers and some systems classified by their vendors as small mainframes, generally have average system prices ranging from $ 100,00 to $ 1 million. Currently shipping models in this category typically support 33 to 128 users in a commercial environment.

Representative systems include IBM's ES 9121, ES 9221 and high end AS/400s, the upper ranges of Digital's VAX series (including all 7000s and 10000s) and their competitors.

Small scale systems typically range from $ 10,000 to $ 100,000. Currently shipping models usually support 2 to 32 users in a commercial environment. Small scale systems are also commonly used in automation, control and commercial processing environments and increasingly as network servers. Representative systems include lower range VAX systems from Digital (including VAX 4000 and 3000, and application DEC 4XX); from IBM the low end AS/400 models and server/multi-user configurations of the RS/6000; and low end multi-user microprocessor-based systems from Siemens Nixdorf, Olivetti, Bull, ICL, Altos, NCR, et al. Also included are high end commodity chip models specifically designed to function as multi-user systems, even if manufactured by vendors typically associated with the PC or workstation market (e.g., the Compaq Systempro or Sun Sparcserver).

Workstations: The category includes single-user workstations from the likes of Sun, Hewlett-Packard and Digital and PC RISC.

Personal Computers (PCs) - are general purpose, single user, microprocessor based machines that are capable of supporting attached peripherals and can be programmed in a high level language. Board level products are excluded. For microprocessor based systems that can support more than one user, IDC bases the distinction between a small scale system and a personal computer on the system's most common configuration. If a system is designed as a server or is multi-microprocessor based, it is classified as a small scale system.

PCs - Portables: portable and transportable machines are included in this category, but electronic organisers (such as the Psion Organiser products) are not counted. Sub-categories acknowledged include AC-portables, battery operated laptops, notebooks and sub-notebooks.

PCs - Desktops: desktop and tower machines are included in this category, but dedicated games machines (such as Nintendo) are not included.

PC Printers include models designed to be attached to PCs, not sold with the systems. These include dot matrix printers, thermal/thermal transfer printers, non-impact page printers, ink-jet printers and colour printers.

Office equipment

Office Equipment includes:

Typewriters: mechanical, electric and electronic typewriters;

Calculators: professional desktop, pocket and hand held models;

Copiers: personal, digital, and colour copiers;

Other office equipment: duplicating equipment (offsets, ink duplicators), cash registers and POS, document filing (microfilm, WORM optical disks), other products (franking, addressing, labelling machines, mail handling systems, etc.).

Data communications hardware

Data Communications Hardware includes the LAN hardware and other data communications equipment markets.

LAN hardware is restricted to the hardware required to link multi-user systems, PCs or workstations to a local area network; it does not include software (e.g., specialised network operation systems) or servers, which are counted in their respective software and system categories.

For this project, LAN connections that come bundled with a system and/or integrated on the mother board (e.g., Ethernet in workstations) are excluded to avoid double counting with the value of systems shipments.

The LAN hardware category includes LAN interfaces, LAN concentrators, terminal servers, internetwork equipment, repeaters.

LAN interfaces: IDC tracks three categories: PC network interface cards (PC NICs), workstation network interfaces and multi-user interfaces. Value is normally assigned on a per-node basis and includes both new networks and nodes shipped into existing LANs.

Intelligent LAN concentrators: for this project are hardware devices that act as central points for star wiring for the nodes attached to the LAN and additionally provide network management functionality over the physical layer.

Terminal servers provide terminal connectivity to the LAN.

Internetwork equipment includes bridges and routers. Bridges connect two networks, operate at level 2 (data link) of the International Standards Organisation (ISO) Open System Interconnection (OSI) model and are protocol-insensitive. Routers are devices that allow for multiple paths, providing two or more connections. They operate at Level 3 (network) of the ISO OSI model and are protocol-sensitive, which allows them to "intelligently" decide how to route data.

Other data communications hardware is for this project expressly limited to hardware and to the following categories, of which it will be the sum: modems, multiplexers, X.25 packet switching equipment, digital switching equipment, frame relay equipment, BRI ISDN cards, communications processors and channel extenders.

Modems tracked by IDC are restricted to analogue and short haul modems, segmented into dial-up and leased line segments and by speed (14.4, 16.8-19.2, 1200, 4800 and 9600 bps); not counted are fibre optic, satellite, pocket, or broad band modems or digital-over-voice (DOV) products.

Multiplexers are devices used to multiplex telecommunications circuits, using time-division and statistical time-division technology. IDC tracks seven market segments: time-division multiplexers, point to point T-1 TDMs, networking T-1 TDMs, T-3 multiplexers (aggregates of 28 DS-1 circuits), and statistical TDMs; not addressed are coaxial or frequency division multiplexers or digital access cross-connect systems.

Packet switching equipment includes all packet switch nodes to route data packets via the most efficient available path and PADS (Packet assemblers/disassemblers) to convert asynchronous and/or synchronous data to the relevant protocol format (e.g., X.25).

Digital switching equipment includes matrix switches (designed to provide local and remote patching, switching and diagnostic functions, typically installed in data processing centres with two or more front-end processors) and data PBXs used to connect terminals to computer ports (increasingly obsolescent due to competition from front-end processors and local area networks).

Communications processors are specialised and customised data communication devices that serve as nodal points for communications between IBM compatible hosts and other nodes on a network. The classical communications processor was a front-end processor configured to

function solely as the interface between an SNA host and a cluster controller attached to 3270 terminals or PCs emulating terminals. Alternatives include remote processors configured as nodes in an SNA network and gateway processors configured to translate and/or route network protocols between SNA and non-SNA nodes.

Cluster controllers are devices designed to control the I/O operations of a group of 3270-type devices, including displays and printers.

Channel extenders are devices that extend the distance over which an I/O channel on a single IBM mainframe can communicate with an IBM compatible peripheral or another IBM mainframe.

The above computer, office, and telecom equipment definitions refer to what the EITO Task Force classifies as general-purpose products. This equipment can be used for a variety of applications in a variety of industries.

In addition to these general purpose products, information technology is also used in a wide range of application-specific devices. These include, but are not limited to: retail point-of-sale systems, automatic teller machines, credit authorisation terminals, smart-card readers, factory data collection systems, numerical controllers for manufacturing equipment, check processing equipment, computer assisted publishing systems, and specialised systems for the military, aerospace and other industries. Taken together these markets are significant.

Readers should keep these definitional issues in mind when working with this volume and other statistical sources. Figures from IT companies, industry research firms and institutions, trade associations, and governments may well include a mix of general purpose and application-specific equipment, complicating attempts to make direct comparisons with the published EITO figures.

11.1.2. Software Products

Software products are commercially available packaged programs for sale or lease from systems vendors and independent software vendors (ISVs), and does not include specially designed application software solutions added by turnkey systems houses to systems acquired from a hardware manufacturer or other third party. The primary IDC categories are systems software and utilities, application tools, and application solutions.

Also, for this project the software products category includes all revenue for packaged software, including fees partially earmarked for software maintenance, services and/or support.

Systems software and utilities are software programs designed (1) to operate hardware through basic operating systems and programming languages, increase the efficiency of systems personnel through system performance measurement tools, improve the operating capabilities of the hardware system by routing the flow of data among machine units and handle data entry and delivery, or (2) to ensure program integrity through maintenance and security programs, convert programs from one language to another, organise data resources through sort/merge products and monitor machine usage. Major components today include operating systems and extensions (e.g., MVS/ESA) and data centre management software, especially automated operations programs. Proprietary operating systems bundled with the hardware in the systems price are typically counted in systems revenue. In addition, programs that allow users to retrieve, organise, manage and manipulate data

and databases are also included. Also included are decision support and executive information system (EIS) programs; spreadsheet programs; front-end and back-end case tools; and emerging areas like co-operative processing and/or object management application development tools.

Application solutions software includes programs designed to provide packaged software solutions for specific problems inherent in an industry or a business function. Such software can address "Cross-industry" functions (e.g., accounting, human resource management, payroll, project management or word processing and other office activities) or specific industry solutions for vertical markets (e.g., banking/financial, manufacturing, health care, oil and gas exploration, etc.).

11.1.3. Services

Professional services

Professional services comprise procurements obtained on a customised or contractual basis for system and/or software development, systems design, integration, installation, related training/education, facilities management and consulting services for information technology purposes only (i.e. management consulting services are not included). The primary professional services activities can be divided into six categories:

- Requirements analysis, planning and strategy, as well as needs assessment for future IT services and equipment. It typically includes audits of hardware, software, personnel, security, work flow etc.
- Systems design represents the detailed deployment plans for the development of a coherent information technology systems out of set resources.
- Contract programming and custom software development represents services (not products) offered on a fixed-fee, cost-plus, or per diem basis for application design, development, integration, and documentation.
- Systems and network implementation and integration includes physical systems integration, migration, system installation, "glue-code", cabling, subsystems integration, tuning, testing, and "burn-in".
- Management and administration constitutes charges for managing and administering a large services contract (e.g. project management for systems integration, or systems and/or network operations in facilities management). It includes overhead costs not captured elsewhere (e.g. human resources in a facilities management contract would be counted, but not the cost of system hardware or packaged software, which would be countered in the proper market category).
- Education and training includes course work and training (both on and off-site) related 1) to systems and/or network installation and/or 2) to software and programming, expect as provided for within a vendors service contract counted within software services above. Excluded from education and training are books and other published material and course work offered through public schools, colleges, universities and non-profit private institutions.

These six categories of activity can be variously applied in a number of ways, including business process redesign, systems integration and facilities management contracts. Professional services as tracked by IDC does not however, include data processing that a vendor may resell from the client's site to a number of unrelated users at other sites, not does it include traditional time-sharing services or so-called processing services.

Processing services

Processing services comprises bureau-type services which can be classified under two further sub-headings; problem solving and transaction processing. Problem solving covers the provision of charged time on systems providing access to computer software tools, models or applications. Transaction processing covers access to specific applications programmes with charges often based upon the number of transactions processed.

Network services

Network services are defined as chargeable value-added services, and comprise: managed network services, network processing services, network messaging services. E-mail, EDI and value-added transport services are typical examples.

Hardware maintenance and support services

comprise, for the purpose of this study, the repair or replacement of components of computer systems hardware (including data communications equipment, but not industry specific terminals like ATMs) and other hardware services, namely: disaster recovery, site planning, installation and relocation. Maintenance revenue may be generated by on-site maintenance, time and materials, parts for self-maintenance and/or depot services, in each case on a service contract or non-contract basis. To avoid double-counting, for this project, support services specifically excludes all software support.

11.2. Telecommunications

11.2.1. Telecommunication Equipment

The market is classified according to the nature of the user:

Customer premises equipment

Includes all the equipment installed at telecommunications users premises:

PBXs (key systems and hybrid systems) private telecommunications switches used for switching incoming and outgoing calls.

Terminal equipment (domestic and business), this segment includes phones, fax machines, telex, videotex terminals and related equipment. Mobile terminal devices are not included in this category.

Mobile equipment (domestic and business), this segment includes mobile terminal devices: cordless phones and GSM handheld devices, car phones, CTx and DECT systems, pagers. Equipment used in the running of a public wireless network is not included.

Other equipment this segment includes (domestic and business) private equipment not otherwise counted above: mainly answering machines, audioconferencing and videoconferencing equipment.

Service providing equipment

This segment includes all equipment used by carriers to provide voice/data network services.

Public switching: local and junction switches, trunk switches, telex switches, data switches, cellular radio switches.

Transmission: multiplexers, microwave, cross connects, line terminals.

11.2.2. Telecommunication Services

Voice network services

This segment includes carrier service revenues for residential, business, national and international voice services and service revenues from analogue, digital and telepoint mobile networks (carphones and personal phones).

Data network services

This segment includes service revenues for the following categories:

Private line services, a private line is a fixed connection between two points. Private lines are leased to a single customer, and only the traffic of that customer can travel through the circuit. Tariffs are based on fixed price per distance segment. No time or traffic related charges are made.

Switched data services, this segment includes service revenues from packet switched data networks (e.g. Transpac) circuit switched networks, value added networks (e.g. GEIS), and ISDN services.

Customer premises equipment installation & maintenance

This segment includes all external installation and maintenance spending on customer premises equipment.

11.3. Performance Measures

11.3.1. Trade Statistics

All trade statistics are presented in current ECU and are based upon official European Community data. Data for the US, Japan and EFTA countries is also based upon data held by the European Community, but in these cases the original source of the information is the appropriate national statistical office. All conventions common in the presentation of such statistics have been observed. For a full treatment of this complex area readers are referred to the publications of the Customs Cooperation Council and Eurostat. Data have been selected based upon standard sub-headings of the Combined Nomenclature as listed below.

The reported areas (or grouping of countries) are: intra-EU (imports/exports occurring between a reporting country and a trading partner that are both within the EU), extra-EU (imports/exports occurring between one reporting/trading country in the European Union and one reporting/trading partner outside the EU), EFTA, US, Japan, 4 Tigers.

Values of imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting member state (fob). The focus of the following analysis is broad, embracing the European Community, the major EFTA states, the US and Japan.

In reporting intra-EU trade it is usual to report the country of consignment as the source of the goods even where this differs from the country of origin. For extra-EU trade the source is generally reported as the country of origin.

List of import/export codes used to value IT and telecommunications hardware trade

84.69	typewriters and wordprocessing machines
84.70	calculators: calculating machines, accounting machines, cash registers, postage franking machines, ticket-issuing machines and similar machines, incorporating a calculating device
84.43.12	offset printing machinery, sheet fed, office type, sheetsize =< 22 x 36 cm
84.71	DP equipment: Automatic data processing machines and units thereof; optical readers, machines for transcribing data onto data media in coded form, and machines for processing data
84.72	"other" office equipment: printers, hectograph or stencil duplicating machines, addressing machines, automatic banknote dispensers, coin-sorting machines, coin-counting (or wrapping) machines, pencil sharpening machines, perforating or stapling machines
84.73	parts for use with the machines of sub-headings 84.69-84.72
90.09	photocopiers
85.17	equipment used for line telephony/ telegraphy: telephone sets, apparatus for carrier-current line systems, telegraphy apparatus, faxes, weather map plotters
85.20.20	telephone answering machines incorporating a sound device

Please note: descriptions have been abbreviated. Product codes have been stated to indicate the level at which data were collected for this exercise. Thus, 84.69 should be considered to include all lower sub-headings below 84.69. Readers interested in the full details of the trade classification are referred to the publications listed below.

References

1. Explanatory Notes to the Combined Nomenclature of the European Community, pub. Office for the Official Publications for the European Communities.

2. Explanatory Notes to the CCC Harmonised System Nomenclature, pub. Customs Co-operation Council.

11.3.2. Production

Limited information is available for the correct evaluation of production, on the basis of the value added contribution of each country.

An approximate relationship is therefore applied to compute production values:

production = market value + exports - imports

where market data is based upon IDC data, and trade data is based upon appropriately adjusted statistics.

For IT and telecommunications hardware this relationship is relatively straightforward to calculate, since data are readily available on both counts. For non-hardware items the lack of suitable trade data prevents a straight forward analysis. For these sectors, estimated trade/ production relationships have been used to complete the analysis.

11.3.3. Industry Leader's Market Share

Market share statistics are based upon aggregations of IDC research, in order to illustrate structural issues within the market, whilst at the same time preserving confidentiality. For example, the figure reported for the leader's share of hardware market in a particular country is in fact an aggregate of the market shares of the individual leaders of each of the standard IDC hardware market sectors.

11.3.4. Industry Concentration

As for the industry leader's (sic) market share (see above), industry concentration is an aggregate market share statistic. In this case, the market positions of the top 10 vendors in each of IDC's primary categories are used to compute the degree of concentration.

11.3.5. Inflation

All forecasts and historical figures include inflation and are stated in terms of local currency growth.

11.3.6. Exchange Rates

All market data and forecasts are presented in constant 1992 exchange rates. The exchange rates used for all except the East European markets are based upon the averages of daily rates for the individual currencies on the Paris money markets, as reported by the OECD.

For Eastern European research the peculiarities of that region have in the past dictated that research be carried out in a different fashion to that used for an established EU or EFTA market. However, the improved stability of Polish, Czech and Hungarian currencies during 1991 has allowed for the introduction of simple translations based upon the local commercial exchange rates quoted below. A different treatment is still necessary for the former Soviet Union. In this case valuations continue to be made relative to a set of initial dollar values for equivalent Western machines. These reference values are then discounted by a variable amount which reflects the system's age. Finally, data are converted into ECU using the appropriate $/ECU exchange rate.

1992 ECU Exchange Rates
(Units per ECU)

Austria	14.27
Belgium	41.75
Denmark	7.84
Finland	5.83
France	6.87
Germany	2.03
Greece	247.40
Ireland	0.76
Italy	1,600.04
Netherlands	2.29
Norway	8.06
Portugal	175.06
Spain	132.99
Sweden	7.56
Switzerland	1.83
United Kingdom	0.74
US	1.29
Japan	163.87
Source: OECD	
Hungary	80.00
Poland	14,500.00
Czechoslovakia	28.00
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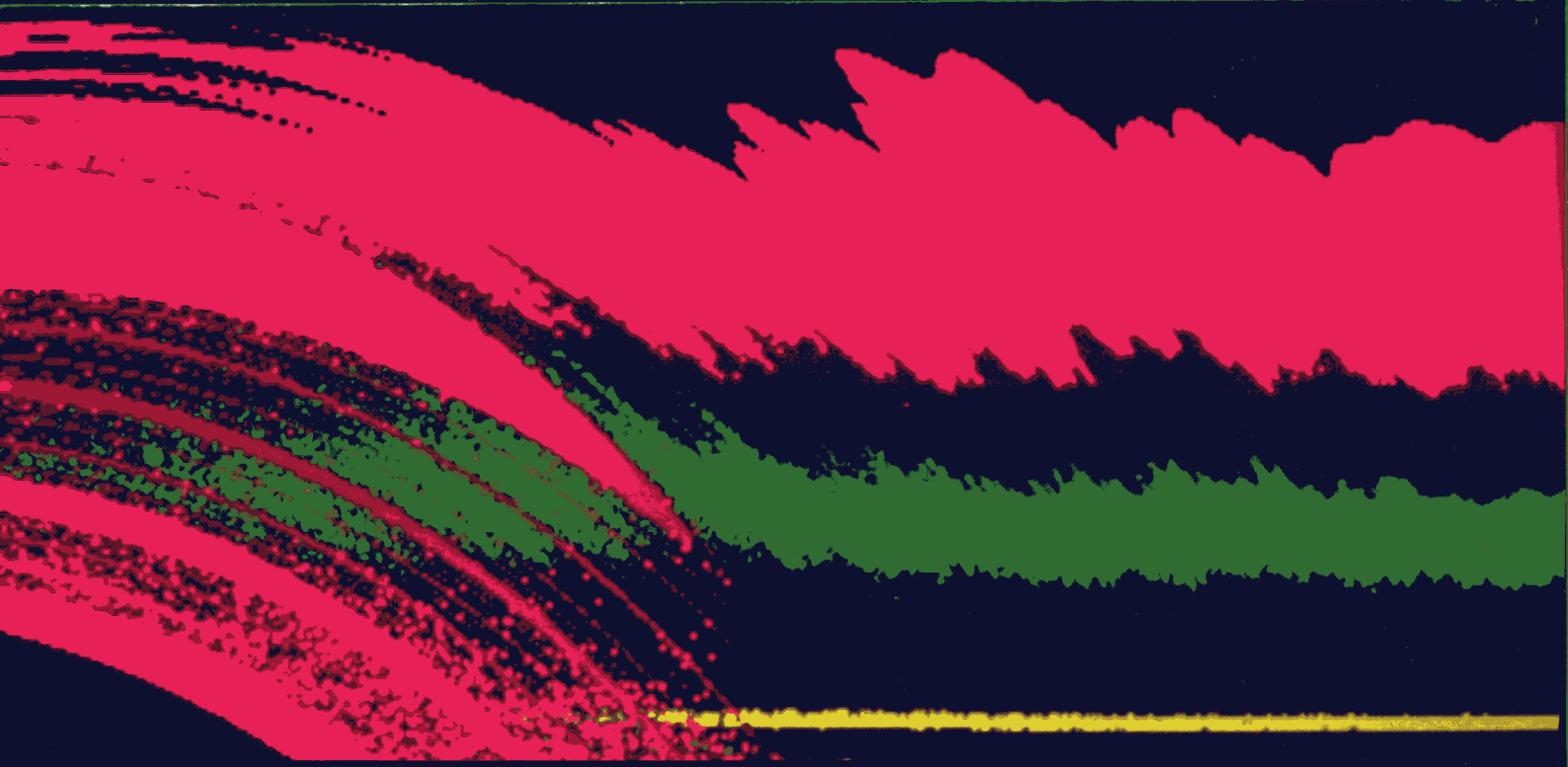
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